Federal Communications Commission Technological Advisory Council Meeting

June 9, 2022

FCC Technological Advisory Council Agenda – June 9, 2022

10:00am – 10:30am	Introduction and Opening Remarks • Welcome Message (TAC Chair) • Opening Remarks by Chairwoman • Opening Remarks by OET Chief • DFO/Deputy DFO Remarks • Member Introduction/Roll Call
10:30am – 11:15am	6G WG Presentation
11:15am – 12:30am	AI/ML WG Presentation
12:30pm – 1:00pm	Lunch Break
1:00pm – 1:45pm	Advanced Spectrum Sharing WG Presentation
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FCC TAC 6G Working Group

Co-Chairs:	Brian Daly, AT&T
	Abhimanyu (Manu) Gosain, Institute for Wireless Internet of Things, Northeastern University
FCC Liaisons:	Michael Ha, Martin Doczkat, Kamran Etemad, Nicholas Oros, Sean Yun
Date:	June 9, 2022

2022 6G Working Group Team Members

Bayliss,Mark	Visual Link Internet		**Flack,Matt**	FCC
Brenner, Dean	Consultant		**Simsek, Meryem**	VMWare
Chandra, Ranveer	Microsoft		**Bali, Ramneek**	Charter
Clegg, Andrew	Wireless Innovation Forum		**Welsh, Patrick**	Verizon
Cooper, Alissa	Cisco		**Tooley, Matt**	NCTA
Cooper,Martin	Dyna,LLC			
Drobot, Adam	Open Techworks			
Forester,Jeffrey	Intel			
Gammel, Peter	GlobalFoundries			
Ghosh, Monisha	Notre Dame			
Guess, Lisa	Cradlepoint			
Kuoppamaki,Karri	T-Mobile			
Lapin, Greg	ARRL			
Manner, Jennifer	Echostar			
Markwalter, Brian	CTA			
Mansergh, Dan	Apple			
Merrill,Lynn	NTCA			
Mukhopadhyay, Amit	Nokia			
Nawrocki, Michael	ATIS			
Nichols, Roger	Keysight			
Peha, Jon	CMU			
Schulzrinne, Henning	Columbia U			
Thakker, Rikin	WIA			

6G WG - 2022 Charter

- Provide information on the **development and deployment of 6G technology**, make recommendations and provide technology insights on new developments that need our attention, from the need for more **spectrum to the vulnerabilities of supply chain to the changing dynamics of global standards development**.
- How does **Open RAN/vRAN** continue to benefit 6G technology development and the ecosystem?
- What are the efforts to ensure an **adequate level of security is provided in Open RAN/vRAN architecture** and what are the cost/benefit tradeoffs to consider?
- What are the opportunities for using **mmW/terahertz bands for fronthaul/backhaul** in support of dense deployment of 6G systems given the capacity capabilities and corresponding bandwidth demands anticipated for 6G systems?
- How is 6G technology envisioned to enhance or be utilized in **autonomous driving, edge computing, emergency alerting, and smart city technology** deployments?
- How can **6G help bridge the digital divide** by bringing down the costs of delivering broadband particularly to rural and urban underserved areas?

Some Areas of Mutual Interest with Other Working Groups

- AI/ML methods and techniques to improve the utilization and administration of spectrum (licensed, unlicensed, and shared) (**AI/ML WG**)
- Emerging edge AI techniques support 6G applications (**AI/ML WG**)
- Use of AI/ML methods and techniques applied to assuring the safety, security, and performance of network equipment, network control, and network operations in a network environment that increasingly relies on automation (**AI/ML WG**)
- Technology insights on new development including the IoT ecosystem and the spectrum access needs for potential high-bandwidth devices; small satellite development, what frequency bands that are under consideration for use, and what services that are envisioned (**Emerging Technologies WG**)
- What are the sharing mechanisms to consider among various services above 95 GHz, including passive services? (**Advanced Spectrum Sharing WG**)

6G WG General Approach

Bottom Line Up Front (BLUF)

- "6G" is an industry term and is yet undefined, with various stakeholders defining a vision for a vision and requirements, spectrum, component technologies, architecture and applications to coalesce towards a shared understanding of what "6G" will be.

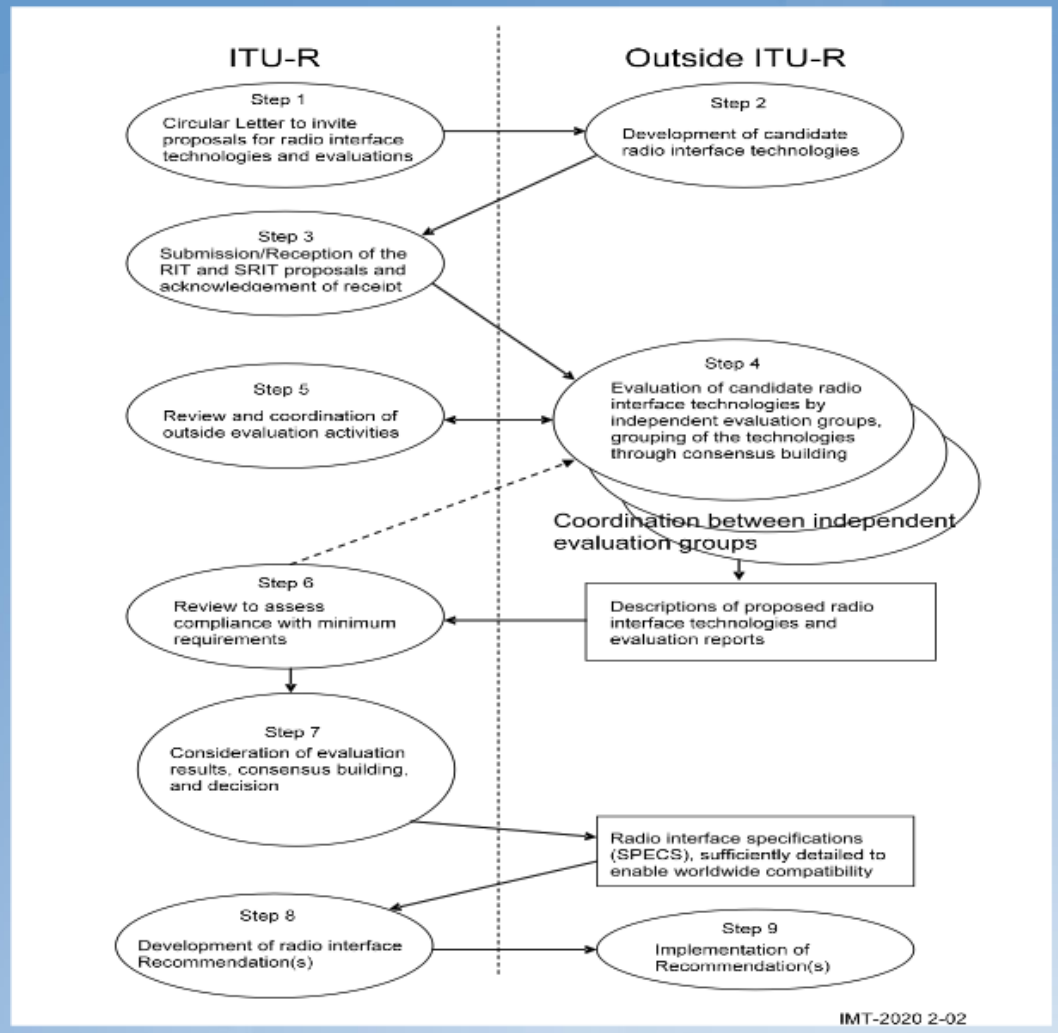
- Multiple charter questions require continued attention and further study.

Topic 1: Key Takeaways Development and Deployment of 6G technology

- What is “6G”?
- What lessons have we learned from global 5G deployments and how will that shape 6G development?
- What is the “6G” timeline?
- What candidate Radio Access, Network, Compute, Chipset Technologies will drive 6G Development?
- What research is underway – in the U.S., globally?
  - What is the role of the Next G Alliance and federal funding agencies in North America?
  - How does the US prepare a competitive workforce to develop and deploy 6G?
- What is the anticipated 6G standardization plan?
  - What standards groups will be involved? (e.g., 3GPP, O-RAN Alliance, IETF, …)
  - What dynamics come into play for 6G standards development?
  - How can US standard representation bodies coalesce to help U.S. maintain standards leadership?
  - What is the risk of fragmentation of standards due to a global pandemic and geopolitics?
- What are the spectrum considerations and timeline for access for 6G?
- How do we get a head start on early potential regulatory barriers that could slow down 6G deployments?
  - Are there issues that could come up in coexistence between 6G and adjacent services regulated in part by agencies other than the FCC which we should highlight now?
  - What are the likely issues about siting for 6G, which implicates state and local government regulation too?
- What are the supply chain considerations and vulnerabilities?

Initial View of Defining “6G”

- “6G” is ***Industry Terminology***, not ITU Terminology.
- ITU-R Resolution 65 defines a process for the development of an IMT.
- ITU-R WP5D is currently defining the Vision for the next generation of IMT beyond IMT-2020, referred to as “IMT-2030 and beyond” and will additionally define a set of Requirements for the terrestrial component of IMT-2030
- ITU-R WP4B is currently defining the Vision and a set of Requirements for Satellite Component of IMT, currently for IMT-2020
- Multiple stakeholders will contribute to define an 6G vision: Terrestrial Mobile Networks, Non-Terrestrial Networks (HAPS/HIBS), Satellites, Hyperscalers, Device Manufacturers, Application Verticals.
- It is anticipated that Multiple Regional, National and Global Telecommunication Fora will shape the IMT-2030 Vision in the coming years.
- An Emerging view is the next IMT will encompass a heterogeneous architecture enabled by licensed, unlicensed and shared spectrum across low, mid and High Frequency bands.
- Open Questions – Which Fora will develop candidate radio technologies (Step 2), participate in the Evaluation process (Step 4), and Implement Recommendations (Step 9) for IMT-2030? How is fragmentation avoided?



IMT-2020 Process

Initial view - What is the Next IMT aka “6G”?

- **ITU Defines a new “Vision” for International Mobile Telecommunications (IMT) ~ every 10 years:**
- ***ITU-R Terminology*** ***Industry Terminology Example (3GPP)***

IMT-2012 (4G)

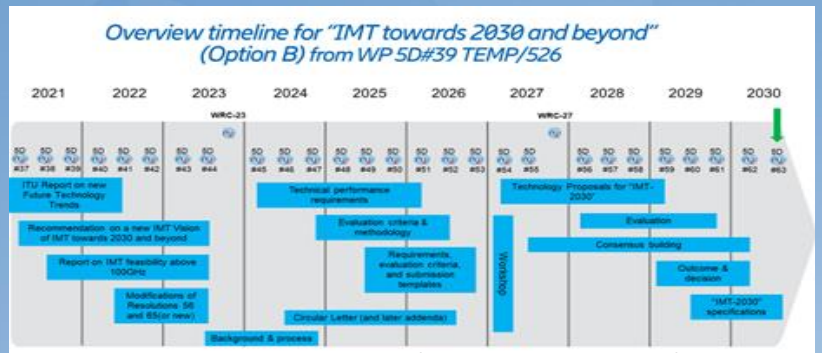
IMT-2020 (5G)
IMT-2030 (6G)

3GPP R15/16/17 | 3GPP R18/19/… | 3GPP ~R21/R22…

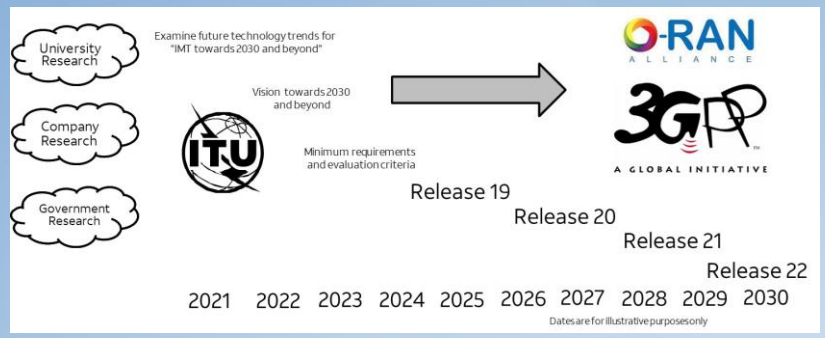
IMT-2030 or “6G”

- 3GPP (for example) develops specifications (submitted as a candidate technology into ITU-R), and labels/brands releases as indicated above. Note: 3GPP 6G branding nomenclature not yet determined
- ITU-R Working Party 5D (WP5D) is currently developing a draft new Recommendation “IMT Vision for 2030 and beyond”, to be completed in 2023
- ITU-R Working Party 4B (WP4B) is currently developing a draft new Report ITU-R M.[SAT-IMT2020.VISION & REQUIREMENTS] - Vision and requirements for satellite radio interface(s) of IMT-2020, to be completed in 2022
- WP 5D is studying future technology enablers for IMT-2030 (draft new Report ITU-R M.[IMT.FUTURE TECHNOLOGY TRENDS]) and aspects of future spectrum capabilities such as those above 100 GHz (draft new Report ITU-R M.[IMT.ABOVE 100 GHz])
- Studies are also underway regarding future spectrum for IMT in conjunction with various WRC-23 agenda items, such as AI 1.2 (Identification of frequency bands for IMT in 3 300-3 400 MHz, 3 600-3 800 MHz, 6 425-7 025 MHz, 7 025-7 125 MHz and 10.0 10.5 GHz) along with other IMT related agenda items (see embedded file)

Anticipated IMT-2030/6G Timeline
(ITU-R & Industry Example)



The timeline between WP 5D #45 meeting and finalization in 2030 is not yet fully determined.



NOTE: FCC Spectrum Allocations for Terrestrial 5G were completed in 2016 and first auctions happened in 2018-2019 and even continue into 2022,

Topic 1: 6G Spectrum Needs

- Generate Recommendations to the Commission on NextGen Technology Development and future (especially 6G) Spectrum Needs. Consider vertical outlook from devices, to sub-systems, to architecture for
  - Frequencies Novel to Commercial Mobile Communications outside of current NPRM proceedings
  - Bands below 600MHz
  - 7.1GHz-24GHz (not including 12.2-12.7 (NPRM FCC-21-13A1))
  - 86GHz-100GHz
  - 100GHz-300GHz
  - 300GHz-1000GHz
  - 1000GHz-3000GHz

- Novel ways of using existing frequencies

- Specific consideration or reconsideration of unlicensed bands designated for mobile communications

Topic 2: Key Takeaways Open RAN/vRAN

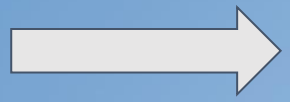
- How does Open RAN/vRAN continue to benefit 6G technology development and the ecosystem?
- Will Open RAN be a "fundamental part of 6G solutions“? What other innovative architecture approaches define 6G?
- What does Open RAN mean for 6G standardization across standard development organizations, e.g. 3GPP, ETSI,ITU and specification forums such as O-RAN Alliance?
- How will AI/ML algorithm design, inference and closed loop optimization paradigm factor in ensuring open RAN is part of 6G?

Topic 2: 3GPP and Open RAN: More Similar than Different

3GPP

Defines Signaling Mechanism
Control Plane Messages
User Plane Messages
Data Transmission Messages
F1/E1 Interface and CU,DU,RU

O-RAN Alliance is consistent with and extends the 3GPP Architecture/Interfaces and will maintain alignment with future 3GPP releases



O-RAN Alliance and 3GPP/ETSI have existing liaisons and O-RAN specifications have been submitted to ETSI under the Publicly Available Specification (PAS) process

O-RAN Alliance

Focus on RAN Optimization and Inline hardware acceleration in the physical layer.

RIC uses AI/ML to optimize RAN

Defines control, user and synchronization plane (CUS) interface

Topic 3: Key Takeaways Security in Open RAN/vRAN architecture

- How will O-RAN implementations be as secure or more secure than closed proprietary implementations?
- What is the security risk assessment of the different O-Cloud/vRAN deployment models, e.g. Private, Public, Hybrid, Community, and the risks in different open RAN cloud deployments?
- How will physical security of component/chip supply chain be implemented?
- How will open RAN architecture specific security requirements and specifications complement 3GPP ?
- Identify new attack surfaces introduced by open RAN logical components such as the RIC(s), the SMO, and O-Cloud, and the software frameworks (e.g., xApps, rApps) ?
- How have specifications addressed potential vulnerabilities in O-RAN components, and potential threats associated with those vulnerabilities that could compromise O-RAN assets?
- How will data integrity and security in context of AI/ML model training be maintained ?

Topic 3: Security Risks in Open RAN/vRAN architecture

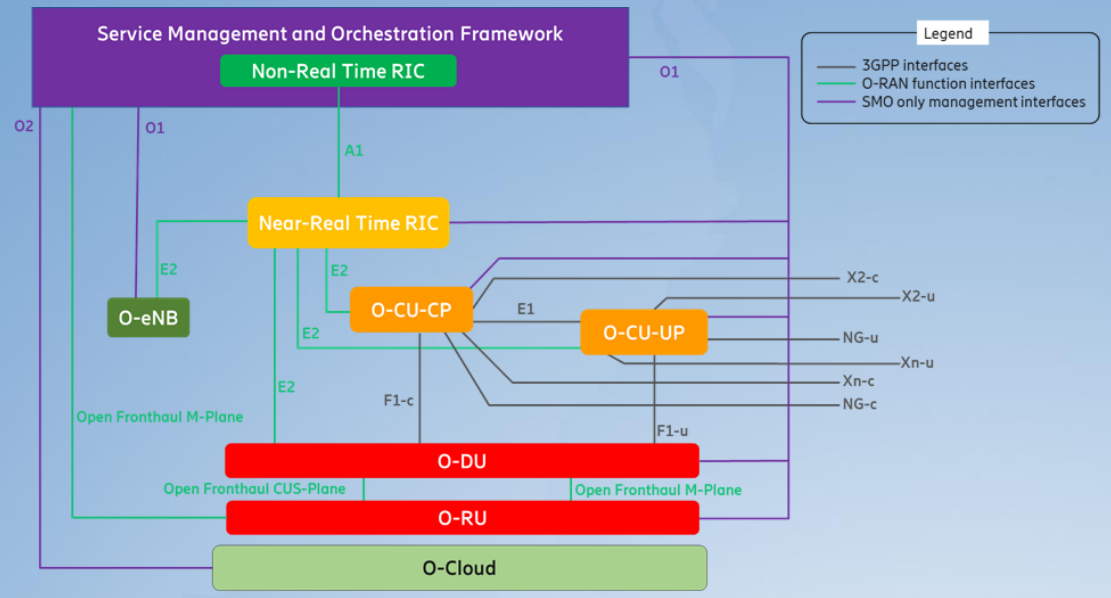
Service Management and Orchestration (SMO)

A security vulnerability within the SMO could be exploited to serve as an entry point for attacks against O-RAN components and lateral movement across O-RAN.

Applications (rApps and xApps)
rApps and xApps use AI and ML. Security of AI/ML data and models is a recognized challenge across all industries that must also be addressed in Open RAN.

Open Fronthaul Interface
Lack of encryption and authentication of control messages on the C-Plane allows modification, injection, and replay attacks that can be used to degrade RAN performance or cause an outage.

O-Cloud
Open RAN shares common cloud security risks. O2 interface for service management and orchestration of the O-Cloud must be secure



Topic 3: Security Risk Mitigation in Open RAN/vRAN architecture

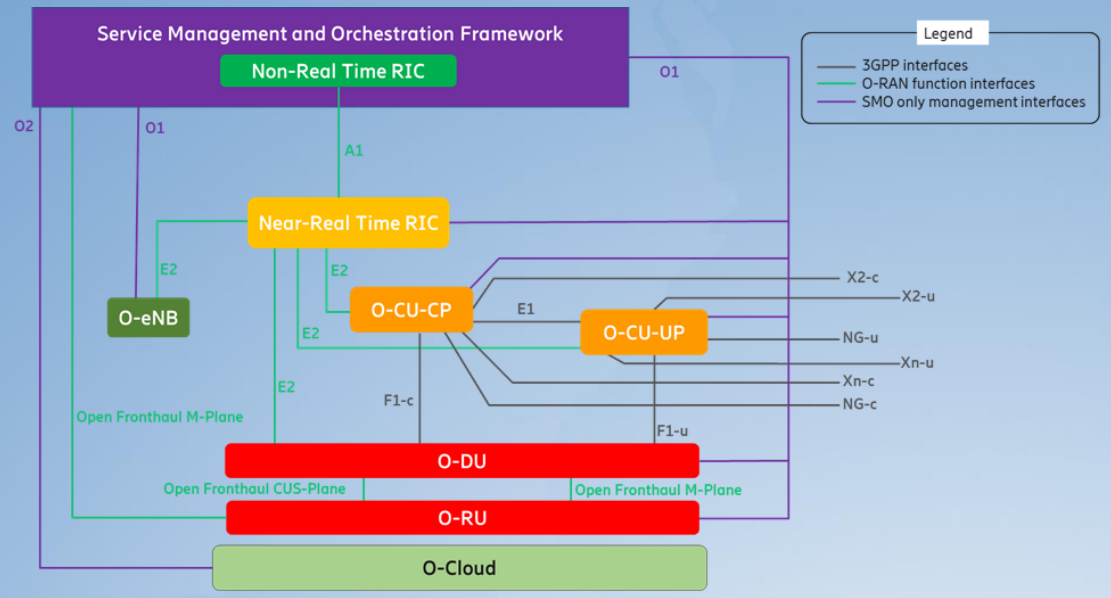
O-RAN Alliance is pursuing a Zero Trust Architecture (ZTA) in accordance with NIST SP 800-207

O-RAN Alliance Security Focus Group (SFG) is focusing on Active Work Items to secure:

- Non-RT-RIC Security
- Near-RT-RIC Security
- Open Fronthaul Security
- O-Cloud Security
- Certificate Management Framework
- Security Test Cases

- Ensure interfaces are secured according to industry best practices such as TLS, IPsec, MACsec, and PKIX certificates

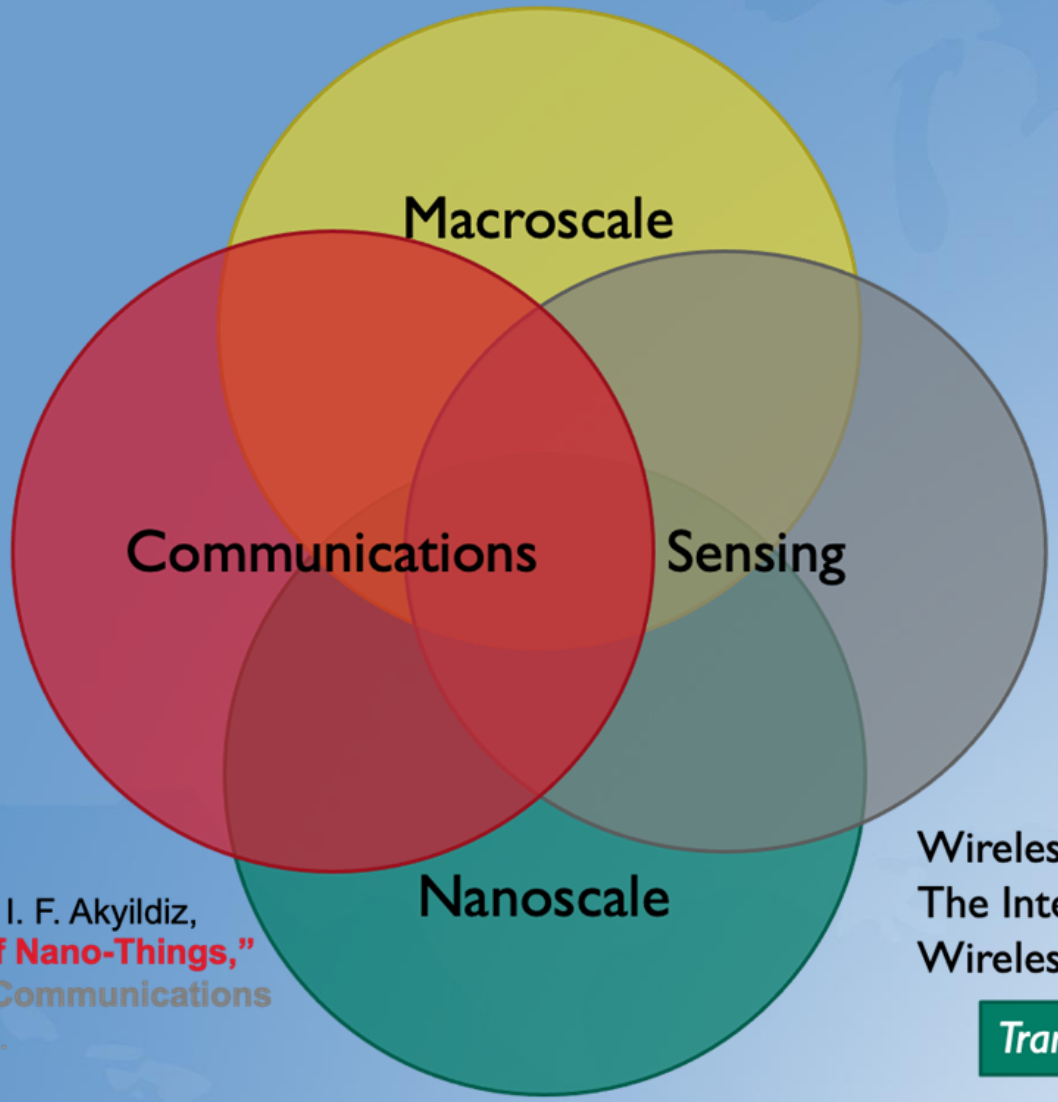
- Practice due diligence and implement cloud security best practices



Topic 4: Key Takeaways for NextGen Technology Development

- What do we expect the network topology to look like for 6G? (5G mmW entails significant densification)
- There has been a lot of work in 3GPP on integrated access and backhaul (IAB) for 5G. We really have not seen IAB deployed yet. Do we envision IAB or other new topology coming into play for 6G?
- What methods or operational capabilities will mmW/terahertz bands use to prevent interference to incumbent EESS (passive) and radio astronomy operations ?
- How will these spectrum frontier bands support topologies such as repeater, sidelink and Device-to-Device?
- What silicon and device innovations will influence development of cost effective chipsets to support broad deployment in these bands?

Topic 4: Opportunities for NextGen Technology



Terabit WPAN/WLAN
Terabit wireless backhaul
Inter-satellite and Space Networks

Bridging the Digital Divide

Climate Change Studies

Wireless Networks on Chip
The Internet of Nano-Things
Wireless Nano-bio Networks

Transforming Healthcare

J. M. Jornet and I. F. Akyildiz,
"The Internet of Nano-Things,"
IEEE Wireless Communications
Magazine, 2010.

Topic 4: Material and Device Challenges to realize the THz vision

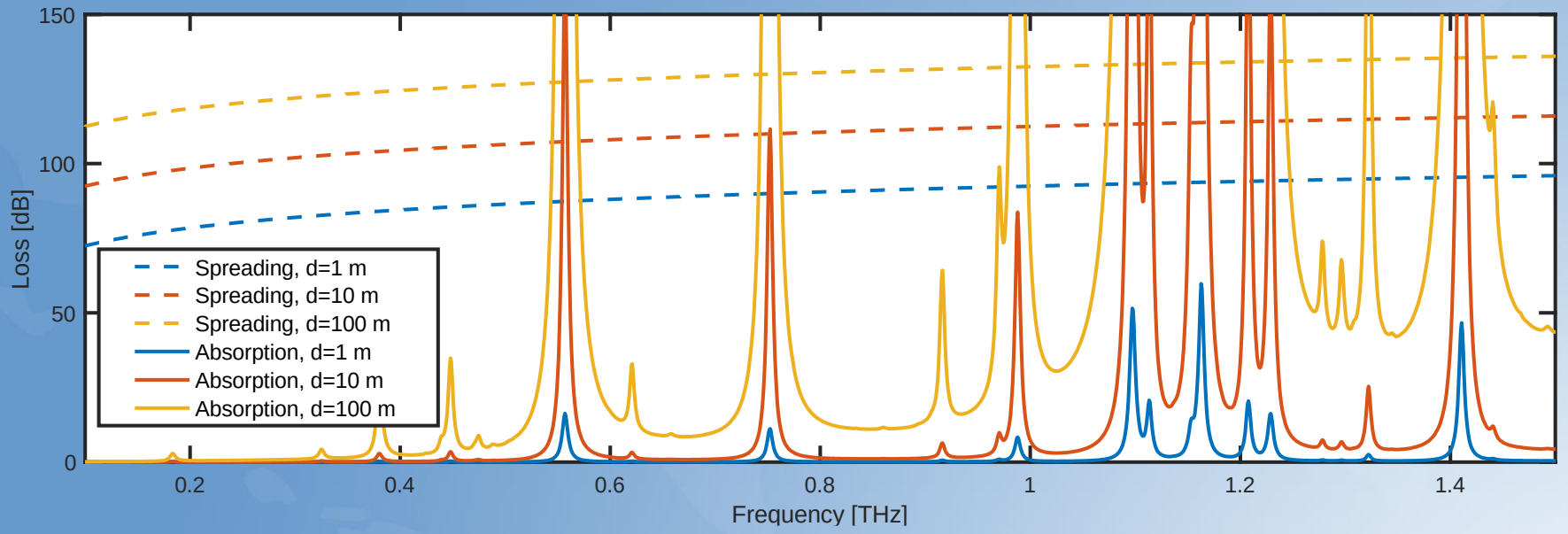
- >500GHz transistors are needed for 6G
  - f t , f max should be > 5x application frequency
  - SiGe has demonstrated performance > 500GHz
  - CMOS/SOI performance plateaus ~450GHz
  - 600GHz SiGe in development with roadmap to 1THz; leverages integration and scale of silicon
  - InP, GaN have best RF Front End performance; requires MCM or 2.5/3D solution within constraints of sub THz arrays

- Progress in realization of D Band phased arrays
  - Evolution of 5G array technology

Topic 4: Propagation and Channel Challenges to realize the THz vision

- The THz band provides nodes with a **huge transmission bandwidth…**
  - … at the cost of a **very high path-loss**

Molecular Absorption	Spreading Losses	Blockage
Solution: Define the right waveform	**Solution:** (dynamic) directional gain	**Solution:** reflecting surfaces



J. M. Jornet and I. F. Akyildiz, **"Channel Modeling and Capacity Analysis of EM Wireless Nanonetworks in the Terahertz Band,"** IEEE Transactions on Wireless Communications, 2011.

Topic 5: 6G for autonomous driving, edge computing, emergency alerting, and smart city technology*

- What are the 6G requirements (spectrum, infrastructure/ubiquitous coverage) to support the aforementioned Industry Verticals and use cases? How will these requirements factor into the standardization process ?
- What are the 6G key enablers, such as THz and AI/ML, that are needed for these services?
- How can 6G address safety for autonomous driving (as well as UAVs)?
- What are the challenges from a security and regulatory perspective? (privacy, etc.)
- How can emerging edge AI techniques support 6G applications?
- Can 6G enhance public warning?
- What will 6G provide to enable smart cities? What are cities expecting?

- **NOT JUST LIMITED TO THE INDUSTRY VERTICALS ABOVE**

Topic 5: 6G for autonomous driving, edge computing, emergency alerting, and smart city technology*

Guiding principles:

- At least one of the following conditions must be satisfied:
  1. The application CANNOT be delivered with prior technologies (5G/5G-Adv) because the feature/functionality are unique, or performance/reliability requirements are too high
  2. The applications CAN be delivered through 5G/5G-Adv BUT their efficiency can be much improved with 6G
     - Capacity, cost, performance, latency, reliability, etc.

Anticipated applications motivating 6G KPIs

- Immersive experiences (e.g., with holography, beyond “conventional” XR)
  - Training, education, healthcare, travel, etc.
- Multi-sensory communication (beyond sight and sound)
  - Representing physical expressions in digital representations
- Tactile internet for remote operations
  - Haptic control with high-definition video feedback
- High resolution mapping and digital twinning
  - Simultaneous activity (example of JCI)
- Cobot operations
  - Precision positioning and sensing
- Level 5 autonomous driving
  - Including the ability to “see around the corner”
- Highly secure communications
  - Mitigate eavesdropping and jamming

<u>Key Performance Indicator(s)</u>
Throughput: Multi-Gbps
Latency: <10 ms
Number of streams: 100’s
Reliability: 7 9’s
Positioning accuracy: < 1 cm
Sensing accuracy: >99%

Topic 6: 6G helping bridge the digital divide

- Will “6G be the first mobile radio generation truly aiming to close the digital divide”?
  - What are the challenges in rural and remote areas?
  - What requirements need to be included in 6G to meet these challenges?
- What are the lessons learned from the pandemic?
- What architectural approaches combining Non-terrestrial and terrestrial connectivity will help provide robust and wide band service in rural areas ?
- How will 6G address spectrum & backhaul for rural areas ?
- What technologies can address cost-performance-coverage to bridge the digital divide?
- Can 6G provide an affordable “sufficient service” compared to solutions for urban/suburban highly population areas?

Topic 6: Factors to consider for 6G helping bridge the digital divide

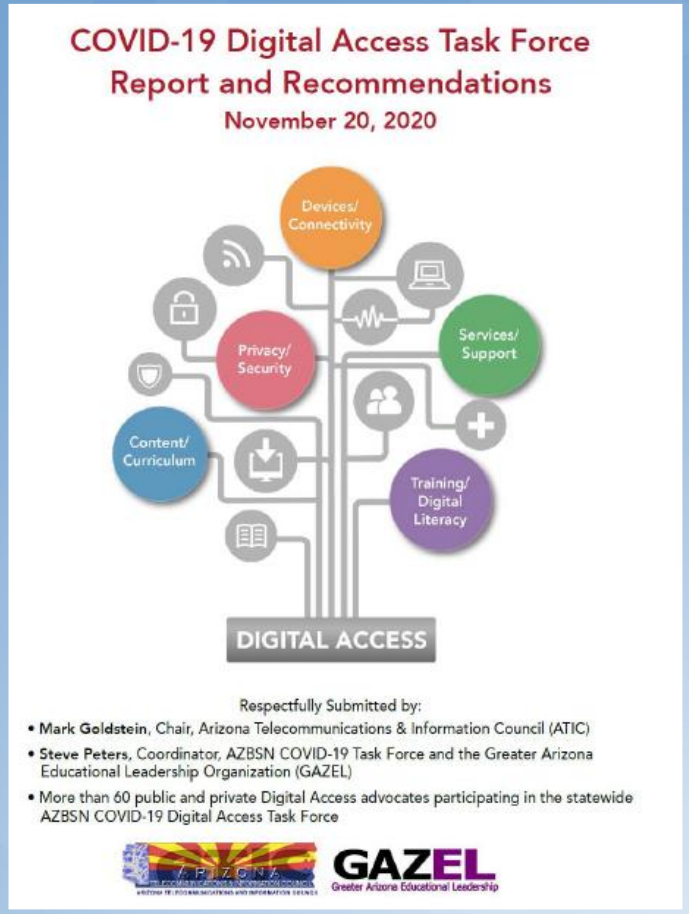
- Lessons from pandemic: **unprecedented demand for digital access**
  - Affordable Internet
  - Digital Inclusion
  - Digital Equity

- **Digital Access** is more than **Internet Access**:
  - Access to computers, smartphones, home hotspots
  - Skills and tech support to use devices, Internet and apps
  - Digital and Web literacy
  - Access to digital content, applications, and other resources

- **Focus** on
  - Education (homework gap for students)
  - Telemedicine
  - Public safety
  - Libraries

- **Challenges** highlight need for public private partnerships.
  - Middle Mile and Last Mile Infrastructure
  - Barriers to Resolving Broadband Deployment (ROI, Access to Right of Way, Funding, etc.)

- **Innovative solutions** to meet the challenges:
  - Smart Highway Corridors
  - Device Refurbishment & Donation Programs
  - "Device as a Service"
  - Broadband and Digital Access Community Teams
  - Electric Cooperatives
  - Funding
  - …

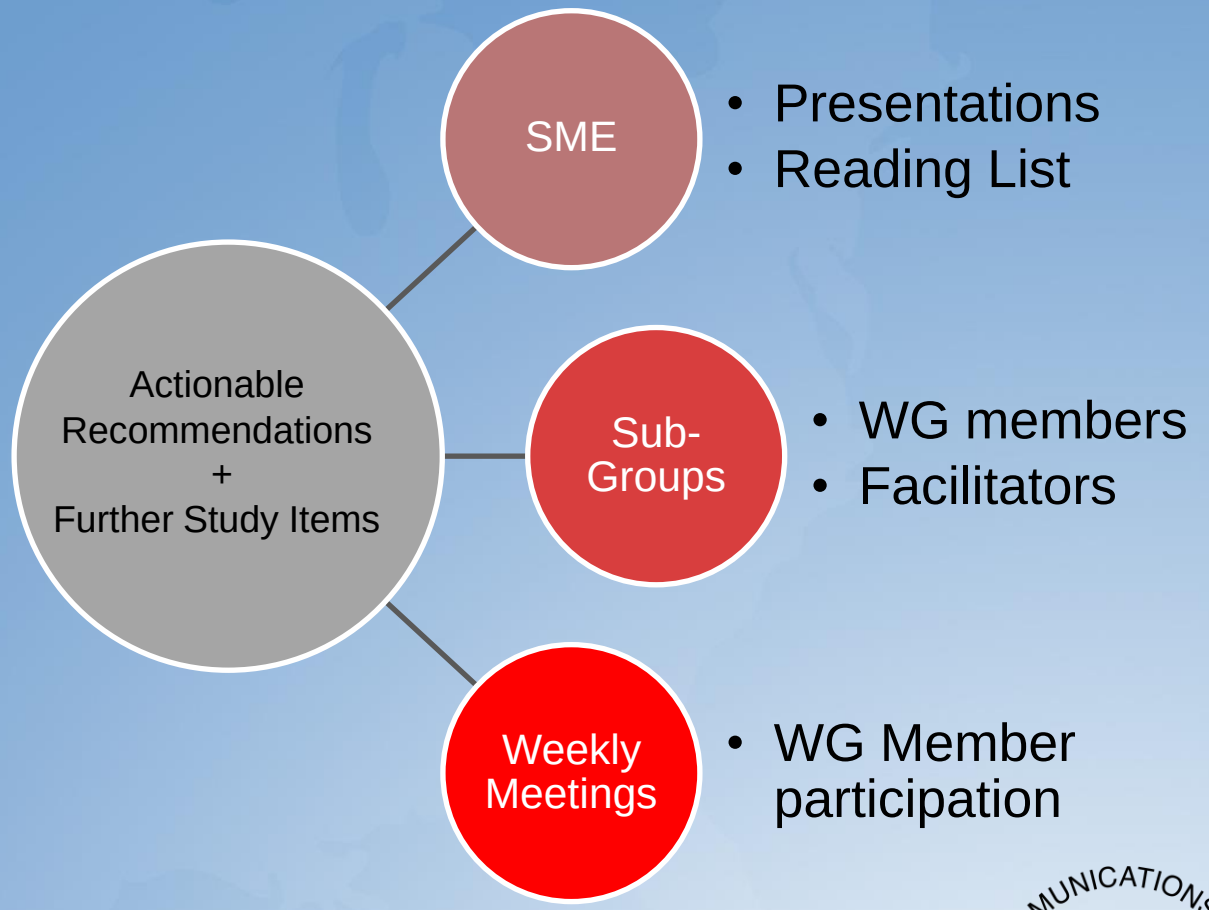


Acknowledgement: Subject Matter Experts

Speaker	Affiliation	Topic
Marc Grant	AT&T	6G Standardization
Geng Wu	Intel	Semiconductor Advances
Clara Li	Intel	Semiconductor Advances
Hua Wang	ETH, Zurich	Semiconductor Advances
Arda Akman	Juniper	O-RAN
Paul Smith	AT&T	O-RAN
Scott Poretsky	Ericsson	O-RAN
Josep Jornet	Northeastern U.	THz
Michael Nawrocki	ATIS	6G Roadmap
Amitava Ghosh	Nokia	6G Roadmap
Douglas Castor	Interdigital	6G Roadmap
Mark Goldstein	Arizona Telecom & Information Council	Digital Divide
Sandip Bhowmick	Arizona Telecom & Information Council	Digital Divide
Steve Peters	Arizona Telecom & Information Council	Digital Divide

Next Steps

- Continue collecting information on assigned Topics
- Start formulating actionable recommendations based on SME presentations and WG member inputs



Thank you

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FCC TAC
Artificial Intelligence and Machine Learning Working Group

Chairs: Lisa Guess, Cradlepoint/Ericsson
Adam Drobot, OpenTechWorks, Inc.

FCC Liaisons: Chrysanthos Chrysanthou, Kambiz Rahnavardy, Patrick Sun, Sean Yun, Michael Ha, Martin Doczkat,

Date: June 9, 2022
FCC TAC Quarterly Meeting

AIWG Members

Name	Organization	Name	Organization
Mark Bayliss	Visual Link	Nageen Himayat	Intel
Nomi Bergman	Advance/Newhouse	Greg Lapin	ARRL
Dean Brenner	TAC Chair	Jose Mejia	RapidSoS
William Check	NCTA	Amit Mukhopadhyay	Nokia Bell Labs
Krishna Chintalapudi	Microsoft	Jack Nasielski	Qualcomm
Martin Cooper	Dyna LLC	Mike Nawrocki	ATIS
Andrew Clegg	WInnForum	Jon Peha	CMU Metro21
Adam Drobot	OpenTechWorks	Balaji Raghothaman	Keysight
Brian Daly	AT&T	Meryem Simsek	VmWare
Alex Diaz-Martinez	FCC Army Fellow	Paul Steinberg	Motorola Solutions
Monisha Ghosh	Notre Dame	Michelle Thompson	ORI
Lisa Guess	Ericsson (Cradlepoint)	Tom Van Meter	Juniper
Mark Hess	Comcast Corporation	James Goel **	Qualcomm (in vetting)

Agenda

- **Charter**
- **Approach**
  - Organization
  - Considerations
  - Methodology
- **Activities to Date**
- **Safe Uses of AI SWG**
- **Results and Products**
- **Summary and Discussion**

Appendix – SME Speakers

Artificial Intelligence, Machine Learning and Computing Working Group - AIWG

Charter

Charter

Artificial Intelligence and Machine Learning WG 2022

1. Expand pilot project proposal(s) from the 2020 TAC session to provide details and associated quality metrics that will allow the Commission to explore, extract the value, and gauge the success of implementing AI/ML techniques.

2. Explore the use of AI/ML methods and techniques to improve the utilization and administration of spectrum (licensed, unlicensed, and shared) by addressing the fundamental aspects of propagation, interference, signal processing, and protocols.

Charter

Artificial Intelligence and Machine Learning WG 2022 - continued

3. Evaluate the use of AI/ML methods and techniques applied to assuring the safety, security, and performance of network equipment, network control, and network operations in a network environment that increasingly relies on automation, is seeing a rapid growth of new network connections, and is increasingly digitized and software-ized.

4. Consider the implications of AI/ML adoption by content providers and the impact on consumers, focusing on understanding causes of and approaches to dealing with addictive behaviors.

Charter

Artificial Intelligence and Machine Learning WG 2022 - continued

5. Formulate a better understanding of uses of AI/ML that may result in modification of human behavior, to develop sound policies that encourage positive outcomes (e.g., public health measures, and other benefits) and mitigate against negative outcomes.

Artificial Intelligence, Machine Learning and Computing Working Group - AIWG

Approach

Approach - Organization

The AIWG has taken the five items in the Charter and organized them as four broad Topics.

Subject	Area Covered	Responsibility
Topic 1	AI/ML Pilot Projects for the FCC	AI/ML Working Group
Topic-2	Safe Uses of AI (Impacts on Consumers, the Network, and the FCC – Security, Privacy, Trust)	Safe Uses of AI Sub – Working Group
Topic-3	Use of AI/ML and Computing for Spectrum Sharing	AI/ML Working Group
Topic-4	Use of AI/ML in Telecommunication Networks (present and future)	AI/ML Working Group

Coordinate with SSWG – Topic-3, and with 6GWG and ETWG – Topic 4

Approach - Considerations

In its approach the AIWG is considering:

1. The questions and issues posed by the charter for FY2022

2. Alignment of the effort with the FCC's current strategic priorities that include:

- **Closing the Digital Divide**
- **Promoting Innovation and Economic Growth**
- **Protecting Consumers & Public Safety (Safeguarding law enforcement communications)**
- **Efficient use of Spectrum**

3. The trends and patterns in the adoption of AI technologies and solutions and their effect on:

- **The FCC's missions and responsibilities**
- **The adoption of AI by operators and how it impacts Network performance, control, management, and the needs of consumer as well as commercial applications**
- **The implications for future network architectures and network demand for services resulting from widespread adoption of AI**

Approach - Considerations

In its approach the AIWG is considering (continued):

4. Input in the from of presentations and discussions with expert on various aspects of AI as applied to issues that affect telecommunications networks including:

- **Projected advances and current results of AI and ML applied to technical aspects of network resource allocation, technical performance, operations,**
- **Impact of AI and ML on business models**
- **The legal landscape for dealing with AI impacts on safety, security, privacy, sensitive private information, data sharing, and issues of fairness and transparency**

5. A broad look at the state of AI and ML technologies and the practical issues in operationalizing AI solutions, and developing effective ecosystems in terms of participation, capabilities, resources, and practices.

6. Coordination with SSWG – Topic-3, and with 6GWG and ETWG – Topic 4

Approach - Methodology

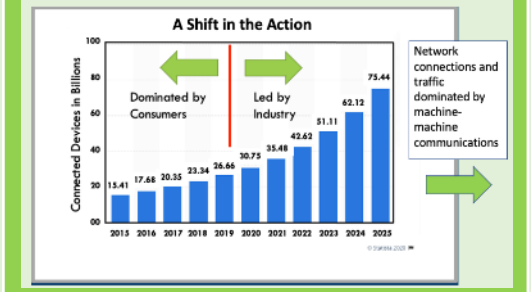
Issues to be Addressed

1. Leveraging National Investments in AI
2. Understanding Data needs for AI
3. Extracting value from AI and Data to address issues of importance to the FCC
4. Safe use of AI

Strategic Priorities

1. Closing the Digital Divide
2. Promoting Innovation
3. Protecting Consumers and Public Safety
4. Reforming the FCC's Processes

Industry Trends



Considerations

1. The FCC's Strategic Priorities
2. Industry Trends
3. Technology Maturity
4. Timeliness
5. Impact

The FCC
Service Providers
Consumers
Industry
The Public Sector

Inputs

1. AIWG SME Discussions
2. External Presentations
3. Supporting Documents
4. FCC Liaisons

Nature of Recommendations

Pilot Project to grow FCC capabilities

Policies and practices accompanying use of AI/ML and Computing

Approaches to optimize efficient and dynamic use of spectrum

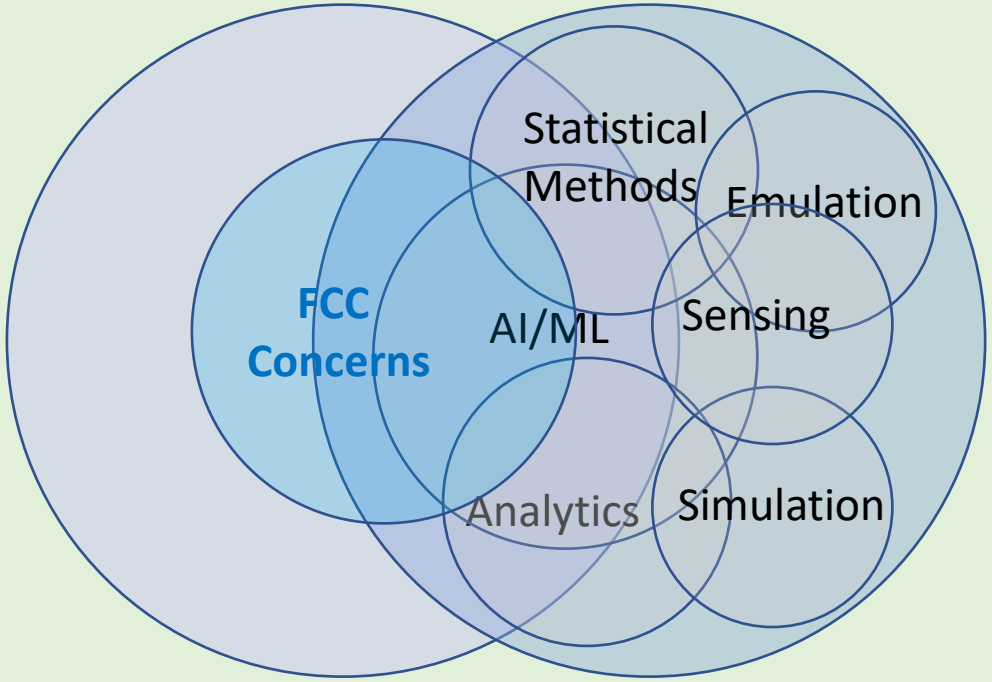
Preparations to anticipate the impact of AI/ML and computing on the Nations Telecommunications Infrastructure

Approach - Methodology

In its approach the AIWG is considering (continued):

Future-scape: Where does AI/ML and Computing Play a significant Role

Explore the Problem Space



Explore the Solution Space

Artificial Intelligence, Machine Learning and Computing Working Group - AIWG

Activities to Date

Activities to Date

Meetings

AIWG Weekly**: Wednesdays 4:00pm-5:00pm Eastern Time**

Safe Uses of AI SWG Weekly**: Thursdays 2:00pm-3:00pm Eastern Time**

Preliminary Discussions and Input that Covered All four Topic Areas

1. AI/ML Pilot Projects for the FCC
2. Safe Uses of AI
3. Spectrum Sharing
4. AI/ML in Telecommunication Networks

Activities to Date

Subject Matter Experts - Targeted Speakers

Internal Discussions

WG Input on aspects of Charter Related AI/ML and Computing Topics

Topic 1: Initial Discussions Identifying Focus
Use of AI/ML for Open RAN and Propagation Models
Topic 2: Summary Follows later in the briefing
Topic 3: Identified Important Aspects (Dynamic Spectrum Sharing and Importance of Propagation Models/Regulations where AI/ML can change the game)
Topic 4: How can AI/ML and Computing
Fundamentally affect what Future Networks Look Like – A Future Scape For the Converged Network.
This has been the main activity to date.

Activities to Date

A Future Scape For the Converged Network.

Preliminary Dialog and Discussions

1. What Problems Need Solving?
2. What will the Network Look Like in the Future?
3. What are the Specific Parameters and Characteristics that will be different in Future Networks?

In the Pipeline

1. What are the Assumptions that Accompany (1-3)
2. How and where can AI/ML and Computing help resolve the problems and contribute to the solutions?

Activities to Date

A Future Scape For the Converged Network.

Preliminary Dialog

1. What Problems Need Solving?

    - Large Scale National and Societal Problems
    - Taming Network Configuration Management
    - Achieving Competitive Network Performance and Efficient use of Resources
    - Security (Privacy, Trust, and Assurance)
    - Network Management
    - Technical Aspects of Network Design, Deployment, Operation, and Performance

Approach - Activities to Date

A Future Scape For the Converged Network.

Preliminary Dialog

2. What will the Network Look Like in the Future?

- High Degree of Automation
- Heterogenous – Ubiquitous Coverage based on Cellular interoperable with other modalities (Satellite, WANs, Point to Point, and Fiber)
- Distributed access end-points everywhere and high bandwidth everywhere – replacement of hard-wired infrastructure with wireless connectivity where possible, coupled with more extensive hard-wired infrastructure!
- Moving away from geographic licensing of spectrum to more dynamic sharing with real time policy-based assignment.
- Plug and play as opposed to Networks run by Operators

Activities to Date

A Future Scape For the Converged Network.

Preliminary Dialog

3. What are the Specific Parameters and Characteristics that will be different in Future Networks?

- High Spectrum Efficiency - bits/Hz
- Much Higher Bandwidths – 10s of Gbits/sec
- Latency – microsecond to millisecond – Support for the Metaverse and Control Applications
- Coverage – bits/pop/Hz, area coverage
- Security, Privacy, and Trust - [Number of good bits]/[Number of total bits] in the same fixed time interval

Approach - Activities to Date

SME Speakers

Speaker	Affiliation	Topic	Date
Acemoğlu, Daron	MIT Economics and Sloan School	Harms of AI/ML	09/21/2022
Barone, Marco Leto	ITI Council EU	Regulations	05/11/2022
Baxter, Kathy	Salesforce	Ethics	07/21/2022
Black, Aeva	Open-Source Initiative	Opensource/IP	TBD
Bowman, Mic	Intel	Security	08/03/2022
Clancy, Charles	MITRE	Security	06/15/2022
Damola, Ayodele	Ericsson	Network Uses	04/27/2022
Davis, Randall	MIT EECS and CSAIL	AI/ML Overview	05/25/2022
Farshchian, Masoud	Mitre (DISA)	Clutter Models	08/10/2022
Friday, Bob	Juniper	AI/ML Activity	04/20/2022
Lobrano, Guido	ITI Council EU	Regulations	05/11/2022

Approach - Activities to Date

SME Speakers

Speaker	Affiliation	Topic	Date
Melodia, Tommaso	Northeastern University	ORAN	07/13/2022
Miche, Yoan	Nokia Bell Labs	Security	07/20/2022
Russell, Stuart	EECS UC Berkeley	Safe Uses	06/08/2022
Sanneck, Henning	Nokia	Networks	07/20/2022
Schirrmeister, Frank	Cadence	Design Tools	08/17/2022
Steinberg, Paul	Motorola Solutions	Responsible Uses	TBD
Vasseur, Jean-Phillipe	Cisco	Practical Use Cases	07/06/2022
Weitzner, Danny	MIT CSAIL	Policy	TBD
West, Nathan	DeepSig	Spectrum Sharing	08/24/2022
Yoo, Taesang	Qualcomm	Wireless	06/22/2022

Artificial Intelligence, Machine Learning and Computing Working Group

Sub-Working Group on Safe Use of Artificial Intelligence

Co-Chairs: Michele Thompson, ORI
Paul Steinberg, Motorola Solutions

Safe Uses of AI SWG

Name	Organization	Name
Members		**FCC Liaisons**
Mark Bayliss	Visual Link	Chrysanthos Chrysanthou
Nomi Bergman	Advance/Newhouse	Kambiz Rahnavardy
Dean Brenner	TAC Chair	Patrick Sun
Krishna Chintalapudi	Microsoft	Sean Yun
Martin Cooper	Dyna LLC	Michael Ha
Adam Drobot	OpenTechWorks	Martin Doczkat
Andrew Clegg	WIE, Google	
Adam Drobot	OpenTechWorks	
Lisa Guess	Ericsson (Cradlepoint)	
Nageen Himayat	Intel	
Mike Nawrocki	ATIS	
Paul Steinberg (Co-Chair)	Motorola Solutions	
Michelle Thompson (Co-Chair)	ORI	

Safe Uses of AI SWG

Scope **(From FCC Charter to AI/ML TAC Working Group)**

Support

3. Evaluate the use of AI/ML methods and techniques applied to assuring the safety, security, and performance of network equipment, network control, and network operations in a network environment that increasingly relies on automation, is seeing a rapid growth of new network connections, and is increasingly digitized and software-ized.

Principal

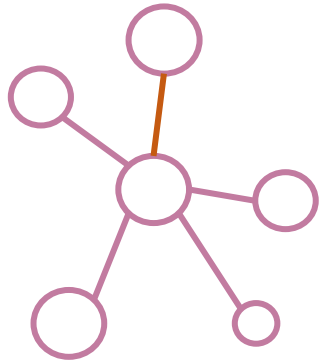
4. Consider the implications of AI/ML adoption by content providers and the impact on consumers, focusing on understanding causes of and approaches to dealing with addictive behaviors.
5. Formulate a better understanding of uses of AI/ML that may result in modification of human behavior, to develop sound policies that encourage positive outcomes (e.g., public health measures, and other benefits) and mitigate against negative outcomes.

Safe Uses of AI SWG

AI / ML
(Intelligence)
Perception
Reasoning
Action

Protects / Directs / Optimizes

Input / Output



Network
(Nervous System)

Increasingly Software-Defined World

Renders, Trains & Rembers

Protects / Optimizes

Embodies Scales

Interconnects / Scales

Cloud
(Brain)

Inter-Dependencies of Compute/Network/AI

Safe Uses of AI SWG

Observations To Date

- The Definition of AI and ML (and thus the scope of related activities) is imprecise, inconsistent and interpreted differently across activities
- European Union Regulatory Activity Insights (Briefing from ITI)
  - Deliberations/Reconciliation in Progress: EU, EP, etc.
  - Expansive Definition of AI
  - Broad Coverage Cross-Use/Cross-Industry
  - Risk-based Approach

1. Unacceptable risk: Banned use (e.g., live face recognition by law enforcement, manipulation, vulnerability exploitation, social scoring)
2. High-Risk: subject to conformity assessment (e.g., critical infrastructure, employement)
3. Limited risk: subject to limited transparency requirements (deepfakes)
4. Minimal risk: out of scope (all other uses)

Safe Uses of AI SWG

Observations To Date

- European Union Regulatory Activity Insights (Briefing from ITI)

High Risk Definition

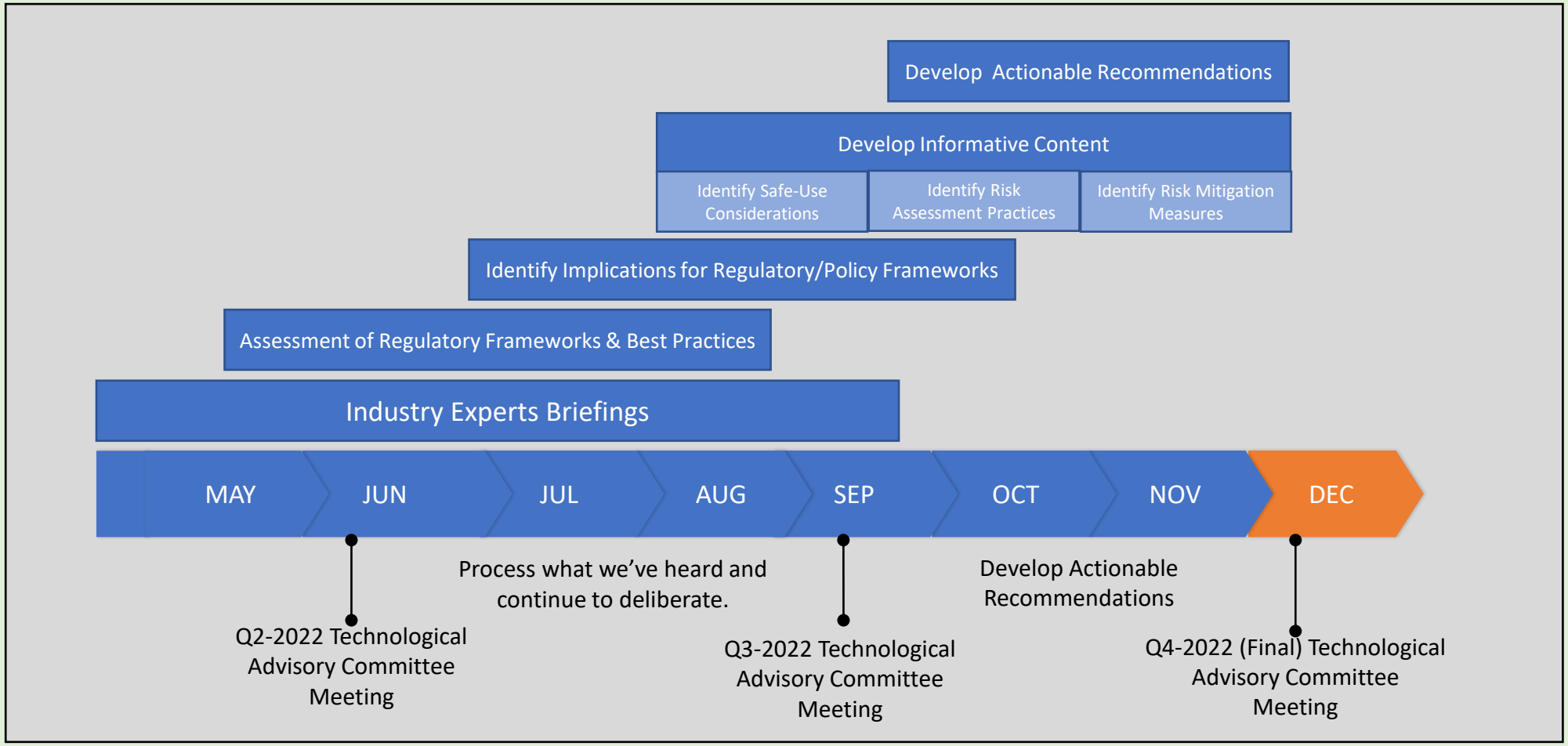
- List of EU product safety sectoral legislation including (machinery, radio equipment, medical devices, vehicles, marine equipment, aviation…)
- The AI system is intended to be used as a safety component for a product or is itself a product
- The product of which the AI system is a safety component, or the AI as a product, are required to undergo 3rd party conformity assessment

Broad High-Risk Uses

- Real time and post remote biometric identification of natural persons
- Safety components for the management of critical infrastructure (heating, gas, electricity, water)
- Determining access to education or training or assessing students
- Recruitment or work-related decisions (promotions, termination…)
- Determining access to public or private services (credit score, emergency response, public benefits)
- Law enforcement (predictive policing, emotion recognition, evidence assessment, profiling)
- Migration (asylum application, emotion recognition)
- Use by a judicial authority

Safe Uses of AI SWG

Plan and Schedule



Artificial Intelligence, Machine Learning and Computing Working Group - AIWG

Results and Products

Results and Products

- Recommendations – Draft for Third Quarter TAC, Final for year-end TAC
  Covering all Four Topic Areas

- Briefings – (1) Detailed Summary and Background for each Topic Area
  (2) Summary and Expected Advances in AI/ML and Computing for Telecommunications and Networking
  (3) Summary of the Landscape for Safe Uses of AI/ML

- Brief White Paper: A Pilot Project for the FCC: Detailed Description of Rationale, Scope, Approach, Required Resources, and Objectives.

Artificial Intelligence, Machine Learning and Computing Working Group - AIWG

Summary and Discussion

Summary and Discussion

- Early in the game: Useful input and discussions so far
- Initial thoughts collected

  We still have a vigorous schedule of SMEs to hear from

  Preliminary sense of significant issues:

  - Sorting out perception of what AI/ML can do and can not do for Telecommunications and for the FCC
  - Initial identification of important areas with current and future impact on FCC
  - Data, Data, and Data

- Expect preliminary notion of observations and recommendations by the next TAC Meeting

Thank You!

Artificial Intelligence, Machine Learning and Computing Working Group

Appendix

FCC TAC AIWG Presentation: April 20th, 2022

Bob Friday
Chief AI Officer
Juniper

Talk Title: **“AI Operations for the Future of Networking”**

- **Biography:** Bob is the CTO and co-founder of Mist Systems, a Juniper Company. He is currently Junipers' Chief AI Officer.

  Bob started his career in wireless at Metricom (Ricochet wireless network) developing and deploying wireless mesh networks across the country to connect the first generation of Internet browsers. After Metricom, Bob co-founded Airespace, a start-up focused on helping enterprises manage the flood of employees bringing unlicensed Wi-Fi technology into their businesses. Following Cisco’s acquisition of Airespace in 2005, Bob became the VP/CTO of Cisco enterprise mobility and drove mobility strategy and investments in the wireless business (e.g., Navini, Cognio, ThinkSmart, Phunware, Wilocity, Meraki). He also drove industry standards such as Hot Spot 2.0 and market efforts such as Cisco’s Connected Mobile Experience. He holds more than 15 patents.

FCC TAC AIWG Presentation: April 27th, 2022

Ayodele Damola
Director
AI/ML Strategy at
Ericsson
Plano TX

Talk Title: **"Leveraging AI/ML in Radio Access Networks (RAN)"**

Biography: Ayodele Damola is the Director of AI/ML Strategy at Ericsson

Ayodele has 17+ years of experience in the telecommunications industry. He works in the MANA CTO Office focusing on driving the AI/ML strategy for North America looking into key market and technology trends in AI/ML and identifying business opportunities and threats.

Previously Ayodele worked in Ericsson Research in Kista, Sweden. He is an inventor with 18 granted US patents.

He holds a Master of Science degree in Computer Networks from the Royal Institute of Technology (KTH) Sweden and has completed professional development programs at Harvard and McGill universities.

linkedin.com/in/ayodele-damola-bba27b4

FCC TAC AIWG Presentation: May 12th, 2022

Guido Lobrano
Senior VP and Director General for Europe at ITI - The Information Technology Industry Council

Talk Title: **"The European Union's Artificial Intelligence (AI) Act"**

Biography: Guido Lobrano is the Senior Vice President of Policy, Director General for Europe at ITI

Guido Lobrano is ITI's Senior Vice President of Policy and Director General for Europe, leading ITI's work on the European Union's activities impacting technology and innovation. Guido is based in Brussels, Belgium, where he opened ITI's first office in Europe. He coordinates ITI's work on EU initiatives in areas such as privacy, cybersecurity, artificial intelligence and data, competition policy and platform issues, and supports the work on digital trade and taxation.

Before joining ITI in October 2017, Guido was deputy director for legal affairs, internal market and digital economy at BusinessEurope, the confederation of European industry. He was in charge of digital and tech policy, as well antitrust and state aid legislation. He also coordinated the team responsible for single market policy.

He led the association's advocacy on Europe's i2010 Strategy and the Digital Agenda for Europe (2012), as well as the 2015 Digital Single Market (DSM) and Digitizing European Industry strategies. He was in charge of privacy and data issues, e-commerce, sharing economy and platforms among others. He covered key legal and policy debates from a cross-sectoral industry perspective, including the 2008-2009 EU Telecoms Review, collective redress (EU-level class action schemes), the process leading to the General Data Protection Regulation (GDPR), the transition from the EU-US Safe Harbor to Privacy Shield.

Guido began his professional career working in law firms in the United States, France, Italy and Belgium, on international and EU law. He is a frequent speaker on a variety of topics, particularly technology and competition policies. He received his law degree in Italy at the University of Sassari and an Erasmus diploma from the University of Vienna.

https://www.linkedin.com/in/guidolobrano/

FCC TAC AIWG Presentation: May 12th, 2022

Marco Leto Barone
Policy Manager – Europe at ITI - The Information Technology Industry Council

Talk Title: **"The European Union's Artificial Intelligence (AI) Act"**

Biography: Marco Leto Barone, Policy Manager – Europe at ITI

Marco joined ITI as a Policy Fellow in March 2019 and now works as a Manager of Policy on ITI's Brussels team. Before joining ITI, Marco worked on tech policy as a Blue book trainee at the European Commission's DG CNECT in Luxembourg. Prior to that, he interned at the Brussels office of the consultancy firm Brunswick Group, where he focused on EU public affairs, technology, consumer issues and financial services. Marco has a background in EU Affairs, and he studied at the University of Groningen in the Netherlands, at the University of Deusto in Spain and at the University of Bologna in Italy.

https://www.linkedin.com/in/marco-leto-barone/

FCC TAC AIWG Presentation: May 25th, 2022

Professor Randall Davis, CSAIL (Computer Science and Artificial Intelligence Laboratory, MIT

Talk Title: **"Artificial Intelligence: What it Can and Can't Do (Yet)"**

Biography: Prof. Randall Davis, CSAIL, MIT

Randall Davis received his undergraduate degree from Dartmouth, graduating summa cum laude, Phi Beta Kappa in 1970, and received a PhD from Stanford in artificial intelligence in 1976. He joined the faculty of the Electrical Engineering and Computer Science Department at MIT in 1978 where he held an Esther and Harold Edgerton Endowed Chair (1979-1981).

He has been a Full Professor in the Department since 1989. He has served as Associate Director of MIT's Artificial Intelligence Laboratory (1993-1998), as a Research Director of CSAIL from 2003-2007, and as Associate Director of CSAIL from 2012-2014.

Dr. Davis has been a seminal contributor to the fields of knowledge-based systems and human-computer interaction, publishing some more than 100 articles and playing a central role in the development of several systems. He and his research group are developing advanced tools that permit natural multi-modal interaction with computers by creating software that understands users as they sketch, gesture, and talk.

He is the co-author of *Knowledge-Based Systems in AI*. In 1990 he was named a Founding Fellow of the Association for the Advancement of AI and in 1995 was elected to a two-year term as its President. From 1995-1998 he served on the Scientific Advisory Board of the U. S. Air Force, earning the USAF Decoration for Exceptional Civilian Service.

Dr. Davis has also been active in the area of intellectual property and software. In 1990 he served as expert to the Court in Computer Associates v. Altai, a case that produced the abstraction, filtration, comparison test now widely used in software copyright cases.

From 1998 to 2000 he served as the chairman of the U.S. National Academy of Sciences study on intellectual property rights and the information infrastructure entitled The Digital Dilemma: Intellectual Property in the Information Age, published by the National Academy Press in February 2000.

https://www.csail.mit.edu/person/randall-davis

FCC TAC AIWG Presentation: June 8th , 2022

Professor Stuart Russell, Electrical Engineering and Computer Sciences, UC Berkeley

Talk Title: **"Artificial Intelligence and Machine Learning"**

Biography: Prof. Stuart Russell, EECS, UC Berkeley

Stuart Russell received his B.A. with first-class honors in physics from Oxford University in 1982 and his Ph.D. in computer science from Stanford in 1986. He then joined the faculty of the University of California at Berkeley, where he is Professor (and formerly Chair) of Electrical Engineering and Computer Sciences and holder of the Smith-Zadeh Chair in Engineering. He is also an Adjunct Professor of Neurological Surgery at UC San Francisco and Vice-Chair of the World Economic Forum's Council on AI and Robotics.

Russell is a recipient of the Presidential Young Investigator Award of the National Science Foundation, the IJCAI Computers and Thought Award, the World Technology Award (Policy category), the Mitchell Prize of the American Statistical Association and the International Society for Bayesian Analysis, the ACM Karlstrom Outstanding Educator Award, and the AAAI/EAAI Outstanding Educator Award. In 1998, he gave the Forsythe Memorial Lectures at Stanford University and from 2012 to 2014 he held the Chaire Blaise Pascal in Paris. He is a Fellow of the American Association for Artificial Intelligence, the Association for Computing Machinery, and the American Association for the Advancement of Science.

His research covers a wide range of topics in artificial intelligence including machine learning, probabilistic reasoning, knowledge representation, planning, real-time decision making, multitarget tracking, computer vision, computational physiology, global seismic monitoring, and philosophical foundations. His books include "The Use of Knowledge in Analogy and Induction", "Do the Right Thing: Studies in Limited Rationality" (with Eric Wefald), and "Artificial Intelligence: A Modern Approach" (with Peter Norvig). His current concerns include the threat of autonomous weapons and the long-term future of artificial intelligence and its relation to humanity.

https://www2.eecs.berkeley.edu/Faculty/Homepages/russell.html

FCC TAC AIWG Presentation: June 15th , 2022

Charles Clancy, Senior Vice President, General Manager, MITRE Labs, Chief Futurist

Talk Title: **"TBD"**

Biography: Charles Clancy, General Manager, MITRE Labs

Charles Clancy is senior vice president, general manager of MITRE Labs, and chief futurist. He is responsible for sparking innovative disruption, accelerating risk-taking and discovery, and delivering real-time technology capabilities and execution through the company's laboratories, solution platforms, and MITRE Fellows program. He leads technical innovation to anticipate and meet the future demands of government sponsors and industry and academic partners.

Clancy is an internationally recognized expert on topics at the intersection of wireless, cybersecurity, and artificial intelligence.

Before joining MITRE in 2019 as vice president for intelligence programs, Clancy served as the Bradley Distinguished Professor in Cybersecurity at Virginia Tech and executive director at the Hume Center for National Security and Technology. There, he led Virginia Tech's research and experiential learning programs in defense and intelligence.

He started his career at the National Security Agency, filling a variety of research, engineering, and operations roles, with a focus on wireless communications. He has co-authored more than 250 patents and academic publications, as well as six books. He co-founded several venture-backed security startup companies that apply commercial innovation to national security challenges.

Clancy is an IEEE Fellow and sits on the AFCEA International Board of Directors' Executive Committee, the AFCEA Intelligence Committee, the Intelligence and National Security Alliance Advisory Committee, the Systems Engineering Research Center Advisory Board, the Alliance for Telecommunications Industry Solutions Next G Alliance, and the Center for New American Security Task Force on Artificial Intelligence and National Security. He also serves on advisory boards at Howard University, Norfolk State University, North Carolina A&T State University, and Virginia Tech. In 2021, *WashingtonExec* magazine named Clancy one of the nation's Top Climate Executives to Watch.

Clancy holds a bachelor's degree in computer engineering from the Rose-Hulman Institute of Technology, a master's degree in electrical engineering from the University of Illinois at Urbana-Champaign, and a doctorate in computer science from the University of Maryland, College Park.

https://www.linkedin.com/in/clancytc/

https://www.mitre.org/about/leadership/executive/charles-clancy

FCC TAC AIWG Presentation: July 6th , 2022

JP Vasseur, Vice-President, Head of Engineering, Predictive Networks, and Cisco Fellow

Talk Title: **"Use cases for AI/ML in Telecommunications and Lessons Learned on developing AI/ML technologies at Scale."**

Biography: JP Vasseur, Cisco Fellow (VP), Head of Engineering, Predictive Networks

JP Vasseur, PhD is a Cisco Fellow and lead of an engineering team developing products where he has been working on several networking technologies such as IP/MPLS, Quality of Service, Traffic Engineering, network recovery, PCE, "Internet of Things" (as the Chief Architect), Security, Wireless Networks since he joined Cisco in 1998. From 1992 to 1998, he worked for Service Providers in large multi-protocol environments, with a key focus on bringing cutting-edge innovation in shipping products.

JP has been an active member of the Internet Engineering Task Force (co-author of more than 35 IETF RFCs, funders and co-chair of several Working Groups such as the PCE and ROLL WG), and in several SDOs.

Since 2010, JP has been leading world class engineering teams of advanced networking and Analytics/Machine Learning (Self Learning Networks, Cloud-based Machine Learning) with key applications such as Security, network cognitive and predictive analytics for Enterprise Networks (wireless, LAN, WAN). JP is a regular speaker at various international conferences, he is involved in various research projects and the member of a few Technical Program Committees. JP Vasseur is also Associate Professor at Telecom Paris.

He is the (co)inventor of more than 500 patents in the area of IP/MPLS, Security, The Internet of Things and Machines Learning / Analytics (#1 inventor at Cisco), with large impact in Internet Technologies.

He is the coauthor of "Network Recovery" (Morgan Kaufmann, July 2004), "Definitive MPLS Network Designs" (Cisco Press, March 2005) and "Interconnecting Smart Object with IP: The Next Internet (Morgan Kaufmann, July 2010 - http://www.thenextinternet.org/).

JP received a PhD in Networking (Mines-Telecom Paris – France, a Master of Science in Computer Science (Steven - USA) and an engineering degree in computer Science (France).

https://www.linkedin.com/in/jp-vasseur-phd/?originalSubdomain=fr

https://www.youtube.com/watch?v=Jb8U1BrJlXo&ab_channel=TechFieldDay

https://newsroom.cisco.com/c/r/newsroom/en/us/a/y2019/m08/meet-cisco-s-top-inventor-jp-vasseur.html

FCC TAC AIWG Presentation: July 13th, 2022

Tommaso Melodia
Director, Institute for the Wireless Internet of Things, and William Lincoln Smith Professor at Northeastern University

Talk Title: **"AI/ML-based Control and Orchestration in the Open RAN: Architectures, Algorithms, and Testbeds"**

Biography: Tommaso Melodia,

- Tommaso Melodia is the William Lincoln Smith Chair Professor with the Department of Electrical and Computer Engineering at Northeastern University in Boston. He is also the Founding Director of the Institute for the Wireless Internet of Things and the Director of Research for the PAWR Project Office. He received his Laurea (integrated BS and MS) from the University of Rome - La Sapienza and his Ph.D. in Electrical and Computer Engineering from the Georgia Institute of Technology in 2007. He is an IEEE Fellow and recipient of the National Science Foundation CAREER award. He was named a College of Engineering Faculty Fellow in 2017 and received the Søren Buus Outstanding Research Award in 2018 - the highest research award in the College of Engineering at Northeastern University. Prof. Melodia has served as Associate Editor fo IEEE Transactions on Wireless Communications, IEEE Transactions on Mobile Computing, Elsevier Computer Networks, among others. He has served as Technical Program Committee Chair for IEEE Infocom 2018, General Chair for IEEE SECON 2019, ACM Nanocom 2019, and ACM WUWnet 2014. Prof. Melodia is the Director of Research for the Platforms for Advanced Wireless Research (PAWR) Project Office, a $100M public-private partnership to establish 4 city-scale platforms for wireless research to advance the US wireless ecosystem in years to come. The PAWR Project Office is co-lead by Northeastern University and US Ignite and is overseeing the overall deployment and operation of the PAWR Program. Prof. Melodia's research on modeling, optimization, and experimental evaluation of Internet-of-Things and wireless networked systems has been funded by the National Science Foundation, the Air Force Research Laboratory the Office of Naval Research, DARPA, and the Army Research Laboratory.

https://www.linkedin.com/in/tommasomelodia/

https://ece.northeastern.edu/wineslab/tmelodia.php

FCC TAC AIWG Presentation: July 20th, 2022

Yoav Miche, Head of Network Security Research at Nokia Bell Labs, Finland

Talk Title: **"AI/ML-based Control and Orchestration in the Open RAN: Architectures, Algorithms, and Testbeds"**

Biography: Yoav Miche PhD, Head of Network Security Research at Nokia Bell Labs

Yoan is currently the head of the Network Security research team in Nokia Bell Labs. He received a double M.Sc. degree in Telecoms and Signal/Image processing from the ENSIMAG and Gipsa Lab, France. He received a double degree Ph.D. in Applied Machine Learning (for watermarking and steganography) from Aalto University, Finland (then Helsinki University of Technology) and the INP Grenoble, France. He was a postdoctoral researcher on industry collaboration projects during 4 years at Aalto University, mainly focusing on applications of machine learning to (cyber)security problems. He joined Nokia Research (now Bell Labs) Finland in 2014 as a cybersecurity researcher and took the lead of the cybersecurity research team in 2018. His topics of predilection include neural networks, anomaly detection, data mining, network security, and he is still fascinated by watermarking and steganography technologies. He was Associate Editor for Elsevier's Neurocomputing from 2012 to 2021, and now serves as a member of the Advisory Board for the journal. He is also on the editorial board (and one of the co-founders) of the Machine Learning and Knowledge Extraction (MAKE) journal. He has been on the Advisory and Stakeholder Boards of several EU projects, recently including the SHERPA project (on the Ethics of AI/ML) and the SAPPAN project (on the sharing and automation of security knowledge).

https://www.linkedin.com/in/yoan-miche-5842533b/?originalSubdomain=fi

https://www.bell-labs.com/about/researcher-profiles/yoanmiche/#gref

FCC TAC AIWG Presentation: July 20th, 2022

Henning Sanneck, Manager, Network Automation Research, NOKIA Standards, Munich, Germany

Talk Title: **"AI/ML-based Control and Orchestration in the Open RAN: Architectures, Algorithms, and Testbeds"**

Biography: Dr. Henning Sanneck, Manager, Network Automation Research

Henning Sanneck is Manager, Network Automation Research in the Standards unit of Nokia Strategy & Technology, Munich, Germany. He received his Dr.-Ing. (PhD) degree in Electrical Engineering from the Technical University of Berlin with a thesis on Voice over IP QoS in 2000. Then, Henning joined Siemens - Mobile Networks as a Senior Research Engineer, becoming an Innovation Project Manager in Radio Network Management in 2003. In 2007, at the formation of Nokia Siemens Networks, he started to lead a line team driving Self Organizing Networks (SON) concepts, IPR and demos for LTE using policy-based management technologies. Since 2009, Henning and his team have been working on applying and adapting analytics and machine learning technologies to Radio Network Management (in particular for anomaly detection and diagnosis) using network data- and simulation-based approaches. In 2014/15, as "Head of Cognitive Network Management" for Nokia Networks Research, he has also acted as the coordinator of the research & standardization work in that technical area which included the strategy development and technology transfer supervision. Henning's team has been continuously involved in nationally (BMBF) and internationally (EU) funded research projects.

His current research interests are in (Beyond) 5G Network Management and Orchestration, in particular configuration, healing and the operation of Cognitive Functions in virtualized, sliced radio access networks (across public and private deployment scenarios). Henning has published 80 papers and has 30 patents granted or published. He has been co-editor and -author of the book "LTE Self-Organizing Networks" (2011) and co-author of the book "Towards Cognitive Autonomous Networks" (2020).

https://www.linkedin.com/in/henning-sanneck-62529819/ and https://sanneck.net/

FCC TAC AIWG Presentation: July 21st, 2022

Kathy Baxter
Principal Architect
Ethical AI Practice at Salesforce

Talk Title: **“Salesforce Ethical AI Maturity Model”**

Biography: Kathy Baxter, Principal Architect, Ethical AI Practice at Salesforce.

- As a Principal Architect of Ethical AI Practice at Salesforce, Kathy Baxter develops research-informed best practice to educate Salesforce employees, customers, and the industry on the development of responsible AI. She collaborates and partners with external AI and ethics experts to continuously evolve Salesforce policies, practices, and products. She is also a member of Singapore’s Advisory Council on the Ethical Use of AI and Data.

  Prior to Salesforce, she worked at Google, eBay, and Oracle in User Experience Research. She received her MS in Engineering Psychology and BS in Applied Psychology from the Georgia Institute of Technology. She is the co-author of "Understanding Your Users: A Practical Guide to User Research Methodologies." You can read about the Ethics AI Practice Team's current research at salesforceairesearch.com/trusted-ai and follow her on Twitter at @baxterkb.

https://www.linkedin.com/in/kathykbaxter/

https://www.salesforce.com/in/blog/authors/kathy-baxter

FCC TAC AIWG Presentation: August 17th , 2022

Frank Schirrmeister, Senior Group Director, Solutions & Ecosystems, Cadence

Talk Title: **"Enabling AI/ML semiconductor and system design and the role of Ai/ML in increasing development productivity"**

Biography: Frank Schirrmeister, Senior Group Director, Solutions & Ecosystem, Cadence

Frank Schirrmeister is senior group director, solutions & ecosystem at Cadence, where he leads a team translating customer challenges in the hyperscale, communications, consumer, automotive, aerospace/defense, industrial, and healthcare vertical domains into specific requirements and solutions. His team focuses on cross-product technical solutions such as 5G, artificial intelligence, machine learning, safety, security, and digital twins, as well as partner collaborations.

Frank holds a Dipl.-Ing. in electrical engineering from the Technical University of Berlin, Germany. Prior to joining Cadence, Frank held senior engineering and product management positions in embedded software, semiconductor, and system development, both in Europe and the United States.

https://resources.pcb.cadence.com/authors/frank-schirrmeister

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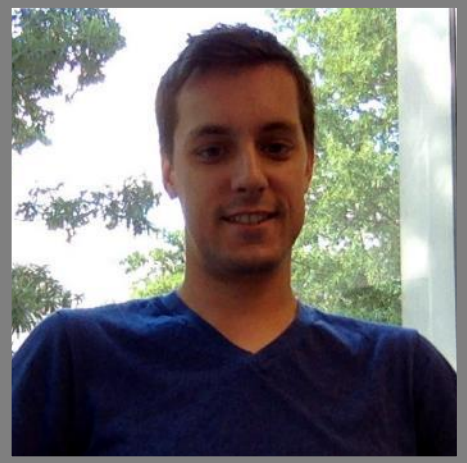
FCC TAC AIWG Presentation: August 24th , 2022



Nathan West, Director of Machine Learning at DeepSig Inc.

Talk Title: **"Benefits and Drawbacks of AI-Native Spectrum Usage and Sharing"**

Biography: Nathan West, Director of Machine Learning at DeepSig Inc.

Dr. Nathan West is the Director of Machine Learning at DeepSig where he leads the development and application of machine learning and AI techniques to wireless communication signal processing products. His research interests include wideband signal recognition and adaptive/reconfigurable radios to develop general-purpose RF systems. At DeepSig his current focus is on productizing and deploying the practical advances in the ai-native signal processing field.

https://www.deepsig.ai/

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FCC TAC AIWG Presentation: September 21st, 2022

Daron Acemoğlu, Institute Professor, Department of Economics and the Sloan School, MIT

Talk Title: **"Incentives and Disincentives for Safe Use of AI" (Proposed)**

Biography: Prof. **Daron Acemoğlu** , Department of Economics and Sloan School, MIT

Daron Acemoglu is Elizabeth and James Killian Professor of Economics in the Department of Economics at the Massachusetts Institute of Technology. He has received a BA in economics at the University of York, 1989, M.Sc. in mathematical economics and econometrics at the London School of Economics, 1990, and Ph.D. in economics at the London School of Economics in 1992.

He is an elected fellow of the National Academy of Sciences (United States), the Science Academy (Turkey), the American Academy of Arts and Sciences, the Econometric Society, the European Economic Association, and the Society of Labor Economists. He has received numerous awards and fellowships, including the inaugural T. W. Shultz Prize from the University of Chicago in 2004, and the inaugural Sherwin Rosen Award for outstanding contribution to labor economics in 2004, Distinguished Science Award from the Turkish Sciences Association in 2006, the John von Neumann Award, Rajk College, Budapest in 2007.

He was the recipient of the John Bates Clark Medal in 2005, awarded every two years to the best economist in the United States under the age of 40 by the American Economic Association, and the Erwin Plein Nemmers prize awarded every two years for work of lasting significance in economics. He holds Honorary Doctorates from the University of Utrecht, Bosporus University, and the University of Athens.

Daron Acemoglu's areas of research include political economy, economic development and growth, human capital theory, growth theory, innovation, search theory, network economics and learning. His recent research focuses on the political, economic and social causes of differences in economic development across societies; the factors affecting the institutional and political evolution of nations; and how technology impacts growth and distribution of resources and is itself determined by economic and social incentives. In addition to scholarly articles, Daron Acemoglu has published four books: *Economic Origins of Dictatorship and Democracy* (joint with James A. Robinson), which was awarded the Woodrow Wilson and the William Riker prizes, *Introduction to Modern Economic Growth*, *Why Nations Fail: The Origins of Power, Prosperity, and Poverty* (joint with James A. Robinson), which was a New York Times bestseller in 2012; and *Principles of Economics* (joint with David Laibson and John List).

http://economics.mit.edu/faculty/acemoglu/index.htm

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FCC Technological Advisory Council Agenda – June 9, 2022

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11:15am – 12:30am	AI/ML WG Presentation
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1:00pm – 1:45pm	Advanced Spectrum Sharing WG Presentation
1:45pm – 2:30pm	Emerging Technologies WG Presentation
2:30pm – 2:45pm	Closing Remarks
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Federal Communications Commission Technological Advisory Council Meeting

(Lunch Break)

June 9, 2022

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FCC TAC Advanced Spectrum Sharing Working Group

Co-Chairs: Andrew Clegg, Wireless Innovation Forum
Monisha Ghosh, Wireless Institute, University of Notre Dame

FCC Liaisons: Michael Ha, Martin Doczkat, Nicholas Oros, Bahman Badipour, Robert Pavlak, Navid Golshahi

Date: June 9, 2022

2022 Work Group Team Members

fcc-tac-ss-wg@googlegroups.com

Ames, Robert	VMware
Arefi, Reza	Intel
Badipour, Bahman	FCC
Brake, Doug	NTIA
Brenner, Dean	Consultant
Chandra, Ranveer	Microsoft
Claudy, Lynn	NAB
Clegg, Andrew	Wireless Innovation Forum
Daly, Brian K.	AT&T
Doczkat, Martin	FCC
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FCC, TAC	FCC TAC
Flack, Matt	FCC

Ghosh, Monisha	Notre Dame
Golsahi, Navid	FCC
Gosain, Manu	Northeastern U
Guess, Lisa	Cradlepoint
Gurney, Dave	Motorola Solutions
Gyurek, Russ	Cisco
Ha, Michael	FCC
Hatfield , Dale N.	University of Colorado
Jindal, Manish	Charter
Lanning, Steve	Viasat
Lapin, Greg	ARRL
Mahdi, Kaniz	VMWare
Manner, Jennifer	Echostar
Mansergh, Dan	Apple

Markwalter, Brian	CTA
Merrill, Lynn	NTCA
Mukhopadhyay, Amit	Nokia
Nasielski, Jack	Qualcomm
Noland, Madeleine	ATSC
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Russell, Jesse	incNetworks
Sawanobori, Tom	CTIA
Schulzrinne, Henning	Columbia U
Scott, Andy	NCTA
Welsh, Patrick	Verizon

Agenda

1. Charter
2. Topic area updates
3. Speakers
4. Results and work product
    a. CBRS example
5. Summary and discussion

Advanced Spectrum Sharing WG - 2022 Charter

- Several sharing mechanisms (static/dynamic or centralized/decentralized) have been deployed to enable sharing between Federal and non-Federal users, licensed and unlicensed users or among licensed users. What are the long-term goals of these approaches? How can AI/ML and sensing-based cognitive radio techniques enhance the effectiveness of the sharing mechanisms and optimize network performance?
- What steps can be taken to better facilitate spectrum repurposing efforts? How can potential intra-band and inter-band issues be identified and addressed early in the process? How can incumbent services be better informed about the nature of adjacent or nearby spectrum environments and how can users be encouraged to take steps needed to accommodate new spectrum uses in those environments? What steps and processes should be used regarding adjacent band spectrum users' wide receiver bandwidths (i.e., the passband extends into adjacent bands)?
- What state of the art filter technologies can be utilized to mitigate potential harmful interference? How can advanced antenna systems help reduce both inter-system and intra-system interference and enhance intra-system performance? What are the cost benefit tradeoffs on utilizing the current filter technologies or advanced antenna systems?
- What are the candidate bands or services that can co-exist with low-power, indoor-only operation such as factory automation? What are the sharing mechanisms to consider?
- What are the sharing mechanisms to consider among various services above 95 GHz, including passive services?

Areas of Mutual Interest with Other Working Groups

- How can AI/ML and sensing-based cognitive radio techniques enhance the effectiveness of the sharing mechanisms and optimize network performance? (AI/ML WG)
- What state of the art filter technologies can be utilized to mitigate potential harmful interference? How can advanced antenna systems help reduce both inter-system and intra-system interference and enhance intra-system performance? What are the cost benefit tradeoffs on utilizing the current filter technologies or advanced antenna systems? (Emerging Technologies WG) (May include any other technology related to sharing)
- What are the sharing mechanisms to consider among various services above 95 GHz, including passive services? (May also consider lower bands) (6G WG)

Topic 1: Potential new bands for sharing

1. Deep dive into 7-24 GHz bands (excluding 12 GHz) (“the rest of midband”)
    a. Which sub-bands are appropriate for sharing/clearing/etc.
    b. Can we extend our techniques from sub-6 GHz to these higher bands or are new techniques needed?
    c. Are specific types of secondary uses most compatible with a given sub-band?
    d. Include global aspect of these sub-bands
2. What are the primary incumbents in these bands?
3. How long should (non-DoD) incumbents be protected if using a non-coexistence approach?
4. What should be the primary coexistence mechanism(s): lightly licensed, licensed, unlicensed, or locally licensed?
5. How best to share with passive services above 95 GHz?

Topic 1 update

- Presentation by Mark Gibson, Comsearch on investigations into the 7 - 8 GHz band.
  - Vast majority of the federal allocations in 7125-8500 MHz are either Fixed or Satellite with number of fixed assignments declining. Approximately 20% of Fixed use is DoD
  - Fixed Satellite use in 7250-7750 (500 MHz, Downlink) / 7900-8400 (500 MHz Uplink) includes Defense Satellite Communications Systems (DSCS) and the Wideband Gapfiller Satellite (WGS)
  - Spectrum occupancy measurements for three cities indicate generally low usage: feasibility of sharing looks promising, but more study is needed to characterize current use
  - Waiting on NTIA's usage assessments and update to compendium: continue to study for relocation/coexistence

- Presentation by Tingfang Ji, Qualcomm on experiments in 12.75 - 13.25 GHz
  - Qualcomm is designing a 6G terrestrial mobile system to operate in upper mid-band spectrum (i.e., 7 - 15 GHz) that uses wide channels (e.g., 100 MHz to 1 GHz) to provide Gbps throughput while providing improved coverage.
  - Focus of new wide area 6G R&D is on 7 – 15 GHz range
  - Incumbents include federal operations (e.g., point-to-point links, radar systems, satellite and radio astronomy) and commercial users (e.g., satellite S2E in 10.7-12.7 GHz and E2S above 12.7 GHz)

Topic 1 update continued

- Presentation by Phil Erickson, MIT Haystack Observatory on passive uses of spectrum
  - Passive radio frequency observations provide unique scientific information, generally in bands dictated by mother nature – they cannot be moved, or traded.
  - The signals being measured are very small, and thus particularly susceptible to interference.
  - Some areas of concern for the passive community:
    - Out of band and spurious emission into passive-only bands
    - In-band emission into shared bands (e.g., when previously ground-based transmissions are allowed to become airborne)
    - Increased utilization of mobile transmissions (interference from fixed sources is generally far easier to ameliorate)

- Next steps
  - Get better information on federal government band use from NTIA
  - Continue investigations into bands up to 24 GHz and beyond 95 GHz
  - Propose suitable bands for new allocations, taking into consideration existing allocations and performance constraints.

Topic 2: Best practices for spectrum sharing

1. Develop standardized/best practices for centralized spectrum sharing
    a. We seem to be looking at each sharing framework anew each time. Can we identify commonalities for future shared spectrum systems, based on learning from TVWS and CBRS?
    b. How band-specific should these sharing mechanisms be?
    c. Lessons learned from W-Fi?
2. Can sharing mechanisms like low-power indoor devices without AFC be extended into new bands?
    a. Are there robust methods of identifying if devices are “indoors”?
        i. E.g.: should devices near windows be more appropriately classified as outdoors?
3. What are some of the considerations related to aggregate interference (its estimation and its actual impact)?
4. Challenges related to incumbent sensing
5. Improved propagation models for spectrum sharing
6. How do we react to reported cases of interference, how do we record & measure it, and how do we effect enforcement when necessary?
    a. Can centralized spectrum management systems be “deputized” to enforce FCC rules?
7. How can we move to more dynamic operations (compared, for example, to CBRS)?

Topic 2 update

- Presentation by Mark Gibson, Comsearch summarizing past spectrum sharing methodologies in FAST, TV White Spaces, CBRS and 6 GHz AFC.
  - Test and certification requirements, processes, timelines and costs must be clearly understood and roles must be clearly defined
  - The roles of the FCC, dynamic sharing system providers and spectrum users regarding Enforcement are unclear and should be discussed
  - Multi-stakeholder groups serve a critical purpose but still require FCC involvement

Topic 3: Receiver standards and technology advances

1. What degree of interference is acceptable to an incumbent in a particular band, and should the responsibility of mitigation fall on the new entrant rather than the incumbent, even if the new entrant is adjacent channel?
2. Should we define a level of interference that the incumbent must be able to accept, i.e. define “harm thresholds”?
    a. If yes, how do we account for legacy devices?
    b. Is such a system as harm thresholds practical?
        i. How does the victim capture the interference data?
        ii. How would the FCC validate complaints and administer harm thresholds?
        iii. What is enforcement mechanism?
3. Smart antenna technologies are primarily being deployed to improve performance (throughput, coverage, density): how may they be better leveraged for spectrum sharing (i.e., directionality, including directionality of nulling)?
4. What are the opportunities for mitigating interference in the time and frequency domain (for example, by active cancellation)?
5. Are we dealing adequately with the the different forms of intermodulation interference?
6. Do advanced filters play a role? Are there operational limitations to filters and their impact on the ability to share spectrum? What are the costs/benefits?
7. Is there an interplay between spectrum sharing and increased risk for security and resiliency, both for the incumbent and the secondary user?
8. What is the role of industry? Should they lead vs regulation/policy?

Topic 3 update

- Presentation by JP De Vries, Silicon Flatirons, on Harm Claim thresholds (HCT)
  - Harm claim thresholds are in-band & out-of-band field strength profile not to be exceeded at more than some (small) % of locations at some statistical confidence level before a system can claim harmful interference.
  - Enable regulators to specify the interference environment in which a wireless system is expected to operate
  - Incorporate reception in rights definitions without reference to receiver performance
  - An engineering prior for addressing legal question of harmful interference
  - Simple to include in rules and measure in the field

- Presentation by Preston Marshall, Google, on Receiver Standards
  - Significant benefit in establishing baseline "*Receiver Assumptions*" that can be used for assessing engineering impact of other uses of the spectrum
    - Not mandatory, but advisory to buyers
    - Could be modified over time as new technology emerges
    - Based only on "Linear" changes in spectrum uses
  - Making these assumptions mandatory would have to be carefully crafted to not distort the market and available technology
    - Short usage that would not be likely to be impacted by any new uses
    - Low cost equipment that would not need to be highly reliable, but would not be viable at higher cost/energy/mass points (like a smart-watch)
    - How to address future changes in usage that impact compliant equipment

- FCC NOI on promoting efficient use of spectrum through improved receiver interference immunity performance

Topic 4: Modeling of interference

1. It is clear from recent spectrum disputes that there is a need for better modeling of potential sources of interference. Example:
   a. Spatial interference rejection potential of Massive MIMO arrays.
   b. Radar altimeter models, end-to-end, not just RF levels of interference.
   c. Propagation models should be focused on interference modeling rather than coverage
      i. Validation of long-distance propagation models such as troposcatter
   d. How to avoid multiple "worst-case" assumptions (i.e., application of joint statistics)?
   e. In a broader sense, how should we deal with statistics of interference, rather than static/deterministic interference calculations? "Risk-informed analysis"
   f. How to adapt interference modeling based on real-world measurements and sharing experience?
   g. Is there a better source of real-time data, such as crowd-sourcing?
   h. Impact of channelization, modulation methods, carrier aggregation, DSS, etc., on interference immunity
   i. Application of statistical models/risk analysis
2. How can potential interference scenarios be tested at-scale prior to rulemaking?
   a. Testbeds, in academia (e.g. PAWR), industry and government (NTIA ITS) labs like ITS.
   b. Industry-accepted interference models for accurate simulations.
   c. Lab testing
   d. Timely testing with all stakeholders engaged can avoid last-minute delays caused by interference concerns.

Topic 4 update

- Interference modeling to be incorporated into recommendations on potential shared spectrum bands
- Future speakers TBD

Topic 5: Economic Incentives of Shared Spectrum

1. Impacts to legacy systems
    a. Is it more economically efficient to pay for legacy systems to upgrade? Is this a viable option in all cases? Most cases? Few cases?
    b. What are the components of legacy systems that need to be addressed? (Front-end filter, pre-amps, IF filters, etc.)
2. Impacts to incumbents
    a. Changes in conops
3. Impacts to the new entrants

Topic 5 update

- Dedicated discussion at May 24 WG meeting
- Economic incentives to be incorporated into recommendations on potential shared spectrum bands
- Future speakers TBD

Speakers

- March 22, 2022: Mark Gibson, Comsearch, Overview of Shared Spectrum, 7/8 GHz
  - Topic 1, Topic 2
- March 29, 2022: Preston Marshall, Google, Receiver Expectations
  - Topic 3
- April 05, 2022: Tingfang Ji, Qualcomm, 6G in 12.75 GHz
  - Topic 1
- April 26, 2022: Pierre de Vries, Silicon Flatirons, Harm Claim Thresholds
  - Topic 3, Topic 5
- May 10, 2022: Phil Erickson, MIT Haystack Observatory, Passive Sharing
  - Topic 1

Work Product 1

- Based on deep-dive examination of bands from Topic 1
- For bands identified as potential “low-hanging fruit” for sharing, examine the bands in terms of the key topic areas:
  - Interference modeling
  - Economic incentives
  - Receiver standards
  - Technology enablers

Work Product 1 example: How CBRS would have been examined

- **Band**: 3550-3700 MHz
- **Primary incumbent**: Military radar, primarily operating on shipborne platforms
- **Additional incumbents**: Extended C-band receive-only earth stations; legacy point-to-multipoint broadband systems
- **Technology enablers**: Spectrum Access System, Environmental Sensing Capability
- **Interference modeling**
  - Establishment and protection of DoD Dynamic Protection Areas (DPAs) and PAL Protection Areas (PPAs) to ensure harmful-interference-free operation of DoD incumbents and tier 2 CBRS users
- **Economic incentives**
  - Incumbents: No relocation; assured continued access to the band with no harmful interference
  - New entrants: Rapid access to 150 MHz of new bandwidth (no waiting for relocation)
- **Application of lessons learned**: Regulatory certainty for new entrants (longer license terms with expectation of renewal) enabling creation of extensive ecosystem of base stations and user devices
- **Receiver standards**: Adoption of minimum blocking performance for CBRS devices

Work Product 2: Lessons Learned

- White paper with recommendations for future shared spectrum endeavors based upon output from Topic Areas 2 (lessons learned) & 4 (interference modeling)

Work Product 3: Receiver Standards (TBD)

- White paper with the following proposed content
  - Catalog of relevant industry/government/academic groups and existing receiver guidelines and standards
    - Demonstrate how broad the issue is (i.e., variety of ITU-R interference criteria)
    - How do the different requirements mesh
  - Requirements for active vs. passive receivers
  - Upgrade incentives
  - Summary Recommendations

Thank You

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FCC TAC
Emerging Technologies Working Group

Chairs: Brian Markwalter, CTA
Henning Schulzrinne, SGE (Columbia University)

FCC Liaisons: Martin Doczkat, Bahman Badipour, Ken Baker, Padma Krishnaswamy

Date: June 9, 2022

Working Group Roster

Mark Bayliss	Visual Link
Nomi Bergman	Advance
Ranveer Chandra	Microsoft
Bill Check	NCTA
Lynn Claudy	NAB
Andrew Clegg	WInnForum
Jeff Foerster	Intel
Peter Gammel	Global Foundries
Dale Hatfield	UC Boulder
Mark Hess	Comcast
Karri Kuoppamaki	T-Mobile
Steve Lanning	Viasat
Greg Lapin	ARRL
Kaniz Mahdi	VMWare
Jennifer Manner	Hughes
Lynn Merrill	NTCA
Michael Nawrocki	ATIS
Madeleine Noland	ATSC
Jesse Russell	Inc Networks
Lewis Shepard	VMWare
Marvin Sirbu	SGE
Ted Solomon	NRTC

Summary Status

- *Emerging Technologies* working group charter covers a wide range of disciplines
- So far, nine subject matter expert speakers on topics from PHY to applications
- More in the pipeline
- Still in “learning and organizing” mode

Charter/Questions Posed

- Provide information on emerging technologies, including the **IoT ecosystem** and the spectrum access needs for potential high-bandwidth devices, that are under development or in use that will improve the US consumer experience on applications related to communications. This should include advances in **semiconductor technologies for RF front ends, antennas and digital basebands**.
- ET Discussion: How is the industry responding to increased demand for connected devices and services and what should the FCC know about these changes?
- SMEs: Marvell, MediaTek, Qualcomm ☑ and Global Foundries, systems like Helium and Sidewalk, high bandwidth devices (e.g., VR), IoT solution providers and breakthrough applications (e.g., agriculture, smart grid), RF selectivity (overlap with Spectrum Sharing working group).

Charter/Questions Posed

- What are the **new features or additional chipsets** that are expected to be embedded into wireless devices, including **UWB and other sensors**, and how would they promote additional services and applications?
- **ET Discussion**: Do current rules allow useful UWB applications? Check UWB waivers
- **SMEs**: FiRa Consortium ☑, Google ☑, wearables company

Charter/Questions Posed

- What are the new tools to **restore internet access during shutdowns** and other disruptions?
- **ET Discussion**: Internet access is different from network access, overlay or redundancy, power availability, forward-looking technologies for restoration, how to rapidly deploy in impacted areas
- **SMEs**: NRECA ☑

Charter/Questions Posed

- What are the network-driven emerging technologies such as **quantum computing** and **blockchain**, and how would they improve user experience in communications services?
- **ET Discussion**: How do smart contracts enable new deployment models for wireless networks? Can tokenized assets be used to trade tower and spectrum? How do these models differ from traditional resale and MVNO arrangements?
- **SMEs**: Althea ☑, Helium

Charter/Questions Posed

- How is **indoor/outdoor location service** envisioned to improve and what are the technologies that are under consideration?
- **ET Discussion**: What are the achievable accuracies under different conditions? What are the trade-offs between using 802.11 and UWB for positioning?
- **SMEs**: IEEE 802.11/Intel ☑, FiRa Consortium ☑

Charter/Questions Posed

- What is the status of **small satellite development**, what frequency bands are under consideration for use, and what services are envisioned?
- **ET Discussion**: TBD
- **SMEs**: Kymeta, Satpaq

Charter/Questions Posed

- What are latest enhancements and capabilities of **cable and broadcasting standards** that may benefit the consumers?
- **ET Discussion**: Role of hybrid broadcast-cellular networks?
- **SMEs**: ATSC ☑, CableLabs, NCTA

Charter/Questions Posed

- What **optical/laser** technologies are being utilized for space or terrestrial communications, what is the performance of these technologies in supporting communications, and what steps should be taken to ensure proper use of these technologies?
- **ET Discussion**:
- **SMEs**: Project Taara ☑

UWB Technology Speakers

- Karthik Srinivasa Gopalan (Samsung), FiRa Consortium technical working group chair
  - Impulse radio UWB, enhanced in IEEE 802.15.4z
  - Very accurate ranging (10 cm)
  - Full protocol stack for secure, accurate ranging
  - FiRa Consortium adds use cases, specifications and certification
- Nihar Jindal (Google)
  - UWB in Pixel phones
  - Pixel 6, first UWB ranging in Google product
  - FiRa and Digital Car Key support
  - Why UWB
    - Accurate ranging
    - Secure
    - Allows data communication
  - Challenges
    - Link Budget
    - Antenna design

ATSC

- Madeleine Noland, president ATSC
- ATSC creates standards and recommended practices for digital broadcasting, most recently ATSC 3.0
- ATSC 3.0 can deliver one-to-many datacasting services as well as linear TV services
- ATSC 3.0 is currently the most efficient one-to-many terrestrial broadcast system in the world
- **ATSC 3.0 can be converged with unicast IP data delivery systems such as LTE, 5G, Wi-Fi, etc.**
- **Dynamic switching of one-to-many sessions from a unicast network to the broadcast network can increase overall efficiency of the unicast network**
  - Example: lots of people watching a live event on a streaming service: transition the event from streaming to broadcast
  - Example: four children in a household needing distance education resources: transition the materials (lecture, reading, etc.) to broadcast, preserve the unicast bandwidth for questions, homework, etc.
- ATSC 3.0 U.S. commercial launch continues apace
  - 140+ NextGen TV models released since 2020; STBs, home gateways (hotspots), dongles and more expected this year
  - Anticipating over 80% U.S. HH reached by EoY 2022
- International interest in ATSC 3.0 is mounting
  - Korea & Jamaica launched services; Brazil selected key ATSC 3.0 technologies for “TV 3.0”; India is actively testing
  - Any final choices by countries expressing interest are TBD

Blockchain and Networking

- Deborah Simpier, Althea
  - (https://www.linkedin.com/company/altheanetwork/)
- “Distributed internet platform for multi-entity networks” via micropayments
- Allows monetization of network-enabling assets like towers and home-based LTE routers
- Smart contracts enable automatic revenue sharing for private networks
- Embed wallets in consumer products for micro-transactions
- Rural and tribal networks leveraging private LTE
- Proof-of-stake network using stable currencies
- Other approaches use proof-of-location and proof-of-bandwidth to incentivize network build outs

Location Services over Wi-Fi

- Ganesh Venkatesan and Carlos Cordeiro (Intel) - IEEE 802.11 support of location services
- IEEE802.11-2020 Fine Timing Measurement Protocol
  - Using 2.4/5GHz bands
  - 1 to 4 meters accuracy
  - No security
- IEEE802.11az – Secure Fine Timing Measurement Protocol (in Sponsor Ballot)
  - Using 2.4/5/6/60GHz bands
  - Less than a meter accuracy (2.4/5/6GHz bands),
  - few centimeters (60 GHz band)
  - Supports security

- Wider adoption of Wi-Fi Certified Location 2.0 expected once IEEE802.11az is ratified

Electric Utility Resilience and Security

- Dr. Emma Stewart, Chief Scientist at the National Rural Electric Cooperative Association (NRECA)
- What rural electric cooperatives are doing to ensure reliability and recovery in the face increasing cyber threats
- Grid is being transformed from a one-way flow (generation to transmission to distribution) to a complex system (generation to transmission to microgrids)
- Communication systems are essential to operating and restoring power
  - Communications network overlaying power grid to pinpoint outages and restore power

Free Space Optical

- John Cooper, Project Taara (Google X)
- Optical communications transferred from Project Loon
- 20 Gbps at 10 km, point to point links
- 193 THz, Class 1 eye safe
- Fog interferes with service
- Quick install, ~$30K
- Proposed as quick-deploy solution during fiber installation or where fiber is difficult (cities)

5G Use Cases and supporting Chips

- Sunil Patil (Qualcomm)

- 5G use cases
- Current 5G networks are based on Rel15 and cater to faster broadband connections
- 3GPP evolution from Rel16, Rel17 to Rel18 intends to enable many new technologies
- Chipsets and RF technology emerging to enable these advanced use cases

Next Generation Passive Optical Networks

- Ed Harstead (Nokia)
- Excellent taxonomy and history of PON technology
- PON leverages technologies matured in other domains
- Transition from 10 GPON to 40 GPON fizzled out
- Data centers driving PON technology cost curve down
- Can we get to 100 GPON without going to coherent optical technology?

Next Steps

- Continue hearing from SMEs
- Are there common themes or patterns?
- What are the impacts on emerging communications eco systems:
  - 6G
  - Wi-Fi 6/7/…
  - residential access networks
  - IoT (beyond the home or building)
  - positioning
  - next-gen broadcast
  - network restoration and backup
- Better define FCC impact (Competition? Resiliency? Special-purpose networks?)
- Do other WGs have questions they'd like answered or entities we should hear from?

Thank You

FCC Technological Advisory Council Agenda – June 9, 2022

10:00am – 10:30am	Introduction and Opening Remarks • Welcome Message (TAC Chair) • Opening Remarks by Chairwoman • Opening Remarks by OET Chief • DFO/Deputy DFO Remarks • Member Introduction/Roll Call
10:30am – 11:15am	6G WG Presentation
11:15am – 12:30am	AI/ML WG Presentation
12:30pm – 1:00pm	Lunch Break
1:00pm – 1:45pm	Advanced Spectrum Sharing WG Presentation
1:45pm – 2:30pm	Emerging Technologies WG Presentation
2:30pm – 2:45pm	Closing Remarks
2:45pm	Adjourned